Solderless Breadboards

Power bus
(red)
Ground bus
(blue)
Component bus

Note that the two sides are not connected.
Wiring Standards

When possible, use wire colors for different types of signals:

- Black: ground
- Red: power
- Other: various signals
Clean Wiring

A clean breadboard will make debugging easier – and it makes circuits more robust

www.linefollowing.com

www.tangentsoft.net
Care with Power

• Only insert components and wires into the breadboard when power is disconnected
• “Wire, check-twice, then power”
  – Never reverse power and ground (this is a very common mistake)
• Most chips that we will use expect +5V
  – More can destroy the chips
  – We will use DC/DC converters to step battery voltages down to +5V
Care of Chips

• Use insertion and extraction tools: never your fingers
• Minimize your contact with pins: static electricity can destroy a chip
• Use a wrist strap when you handle chips

TTL Chips: 2-Input AND Gates

Chip number: 7408

Pin 1 is marked on the chip

Ground

Power

Vcc

GND
Wiring Procedure (Suggested)

- Power supply
- Power/ground buses
- Insert primary components
- Wire power/ground for components
- Add signals and remaining components
- Test incrementally
Debugging Techniques

• Multimeter:
  – Use *voltage mode* to check logic levels
  – Use *continuity mode* to confirm connections (but never with power turned on!)

• Oscilloscope:
  – View voltage as a function of time on 2 channels

• Test incrementally

• Test intermediate sub-circuits
A Basic Circuit
(Projects 2-4)
A Basic Circuit

- Connect through adapter to AVR ISP
- Do not reverse the pins!
A Basic Circuit

Extra LED allows you to see when a program is being downloaded
A Basic Circuit

16 MHz crystal

• (generally optional)

• Without it, your processor will run at 1MHz (we want the 16MHz clock)
Lab Procedures

• No food or drink are allowed in the lab.

• Before leaving the lab, please be sure to clean up your workspace.

• Because some equipment may be in short supply, please coordinate with others who will need these resources.

• Never place dead components back into the stock (instead – place them in the ‘graveyard’).
Lab Procedures

• No equipment or supplies may leave the lab without the permission of the monitor.

• No books may leave the lab.

• Please clear all guests with the lab monitor.

• Unless you have prior permission, please do not handle the projects of other class members.
Lab Procedures

- Always check your wiring before you power up your circuit (especially your power and ground connections).

- When removing chips from breadboards, always use an appropriate tool (not your fingers!).

- If you break something, please report it (don't just put it away).

- You are expected to supply and configure your own laptop computers for project use.