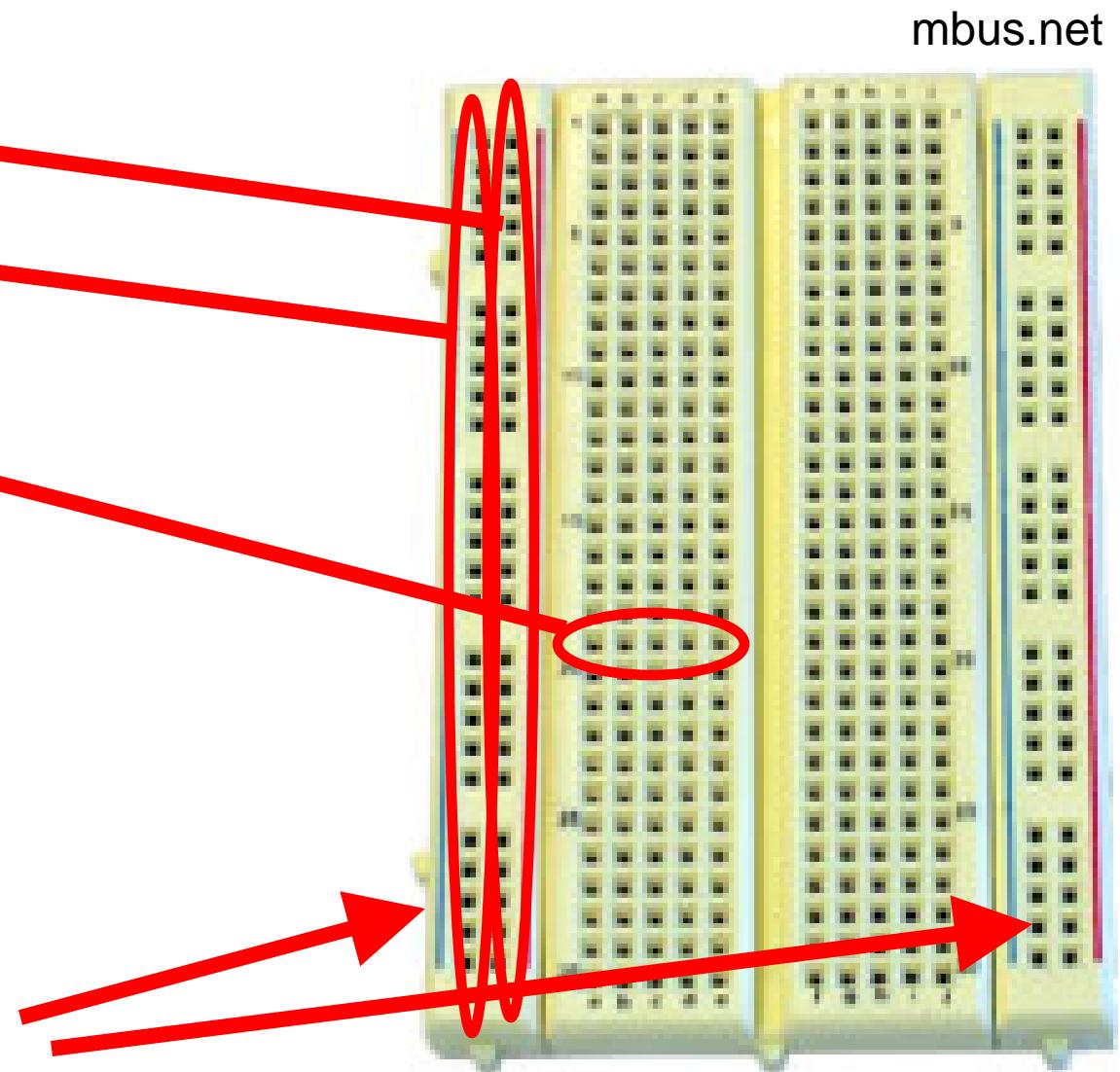


# Solderless Breadboards

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

Note that the two  
sides are not  
connected



mbus.net

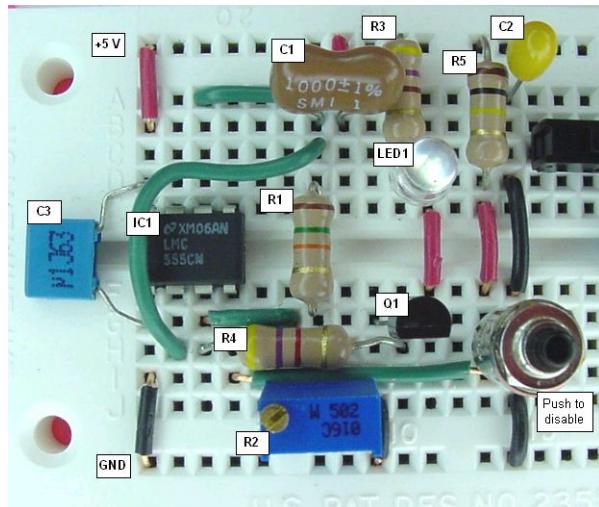
# Wiring Standards

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

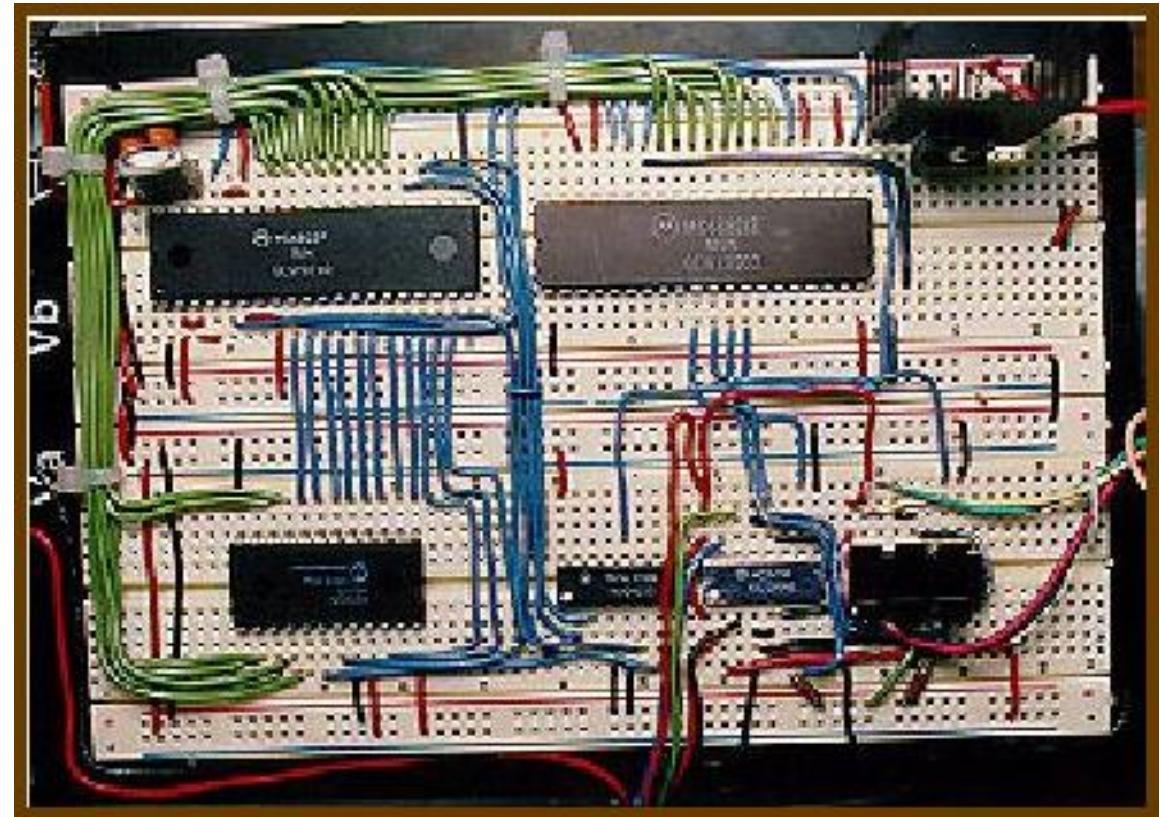
- Black: ground
- Red: power
- Other: various signals

# Clean Wiring

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



[www.linefollowing.com](http://www.linefollowing.com)



[tangentsoft.net](http://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



[www.chantronics.com.au](http://www.chantronics.com.au)

[www.a7vtroubleshooting.com](http://www.a7vtroubleshooting.com)

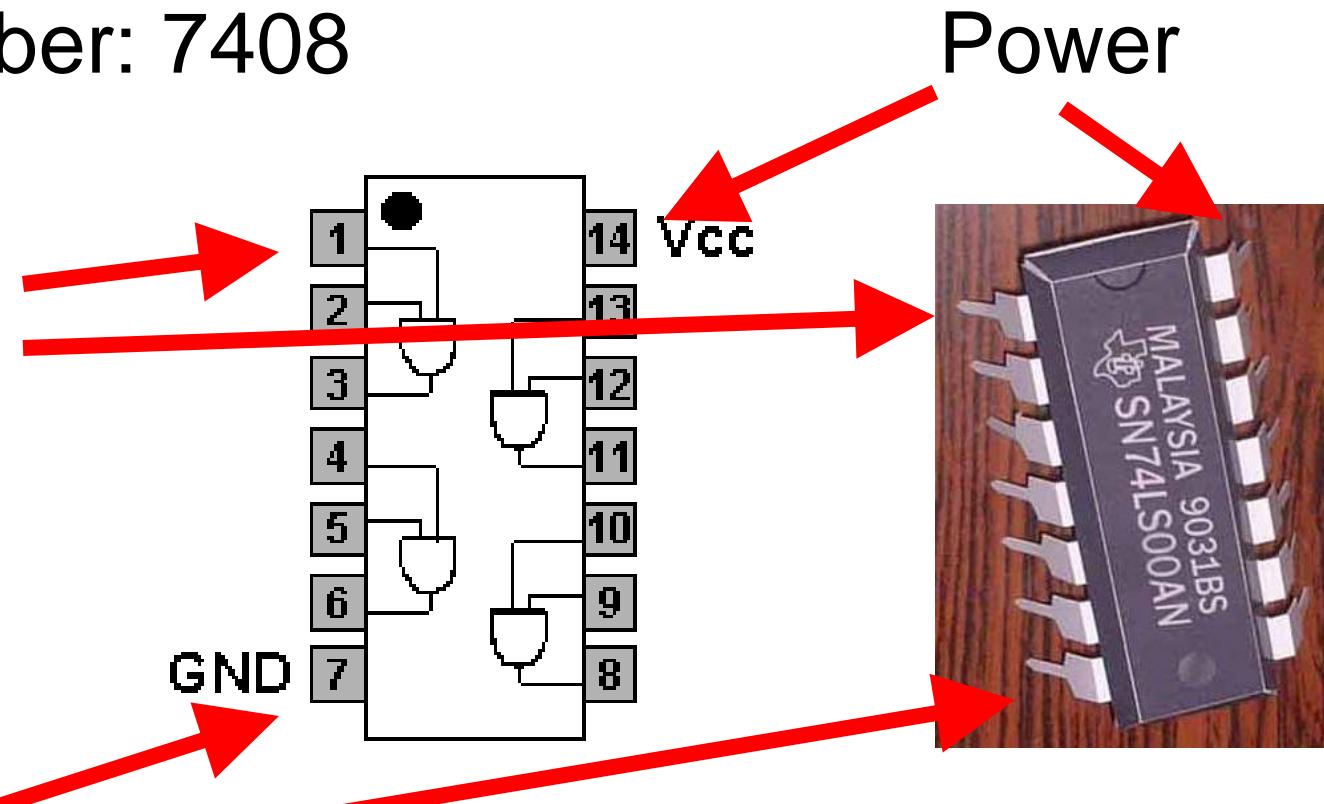


[www.hvwtech.com](http://www.hvwtech.com)

# TTL Chips: 2-Input AND Gates

Chip number: 7408

Pin 1 is  
marked  
on the  
chip



Ground

# Constant Inputs

How do we configure a chip input as a constant?

# Constant Inputs

How do we configure a chip input as a constant?

- For a constant 0: connect to ground
- For a constant 1: use a pull-up resistor to +5V (e.g., 10K ohm)

# Wiring Procedure (Suggested)

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

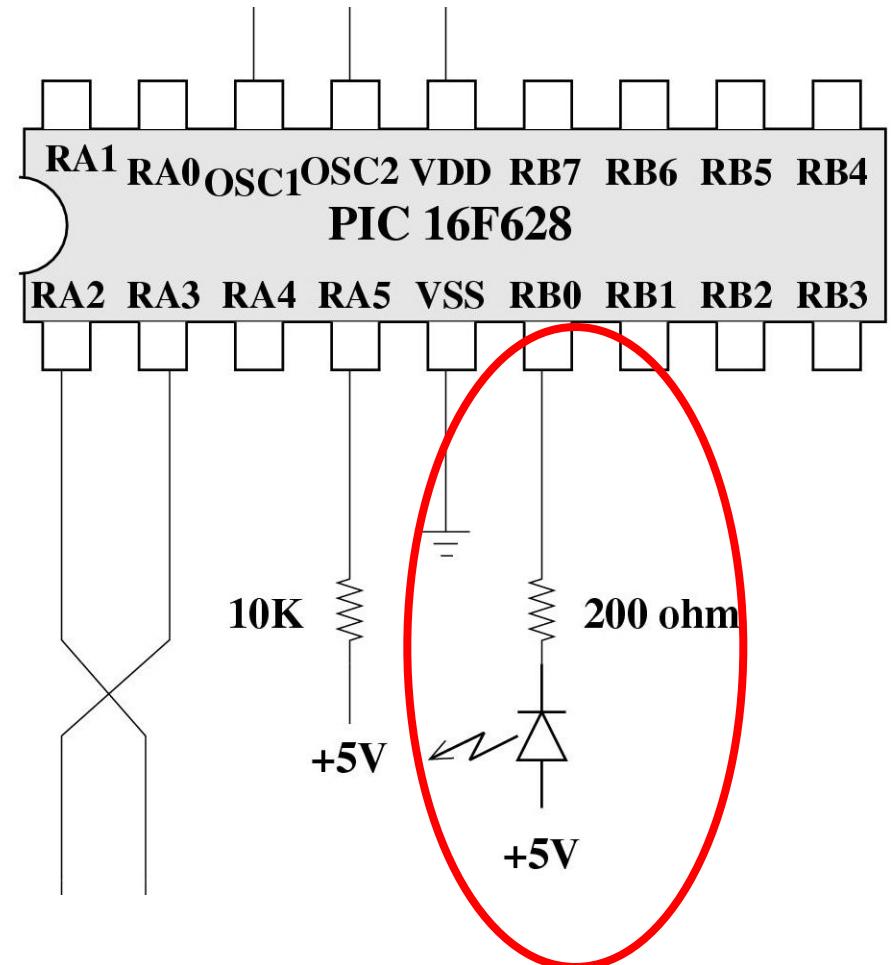
# Debugging Techniques

- 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

# Debugging Techniques

Wire in LED to indicate logic level on a line

- For most components, do not allow the line to be driven by more than 20mA (check the specs if in doubt)
- Note that in this circuit, the LED turns on when logic level is LOW

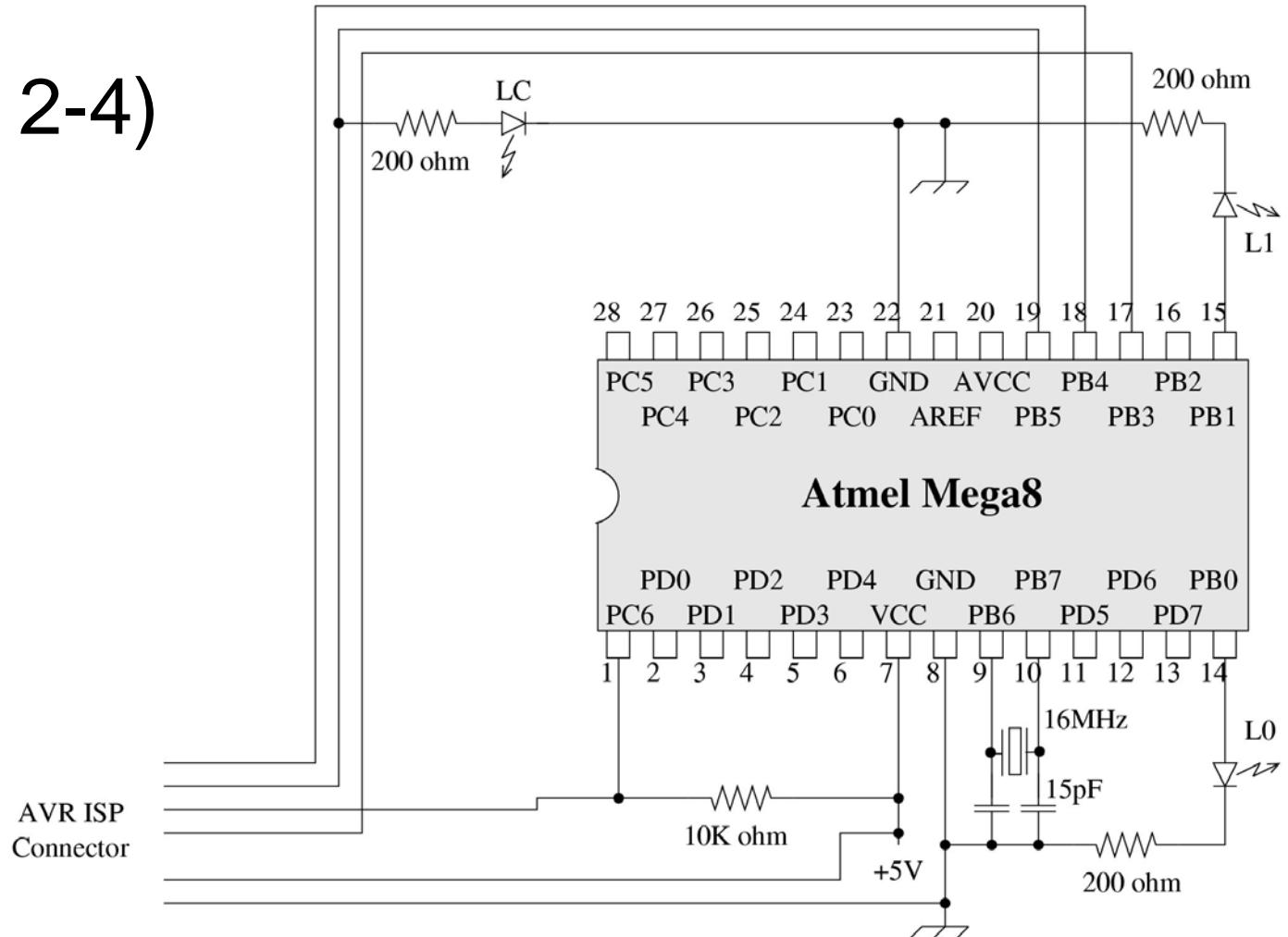


# Debugging/Safety Hints

- Start by testing your circuit prior to connecting motor power
- Before connecting power: position arms so that they are near their default positions (middle of the joint ranges)
- You can test the wheel control with the robot up “on blocks” (so that the wheels are not touching the ground)

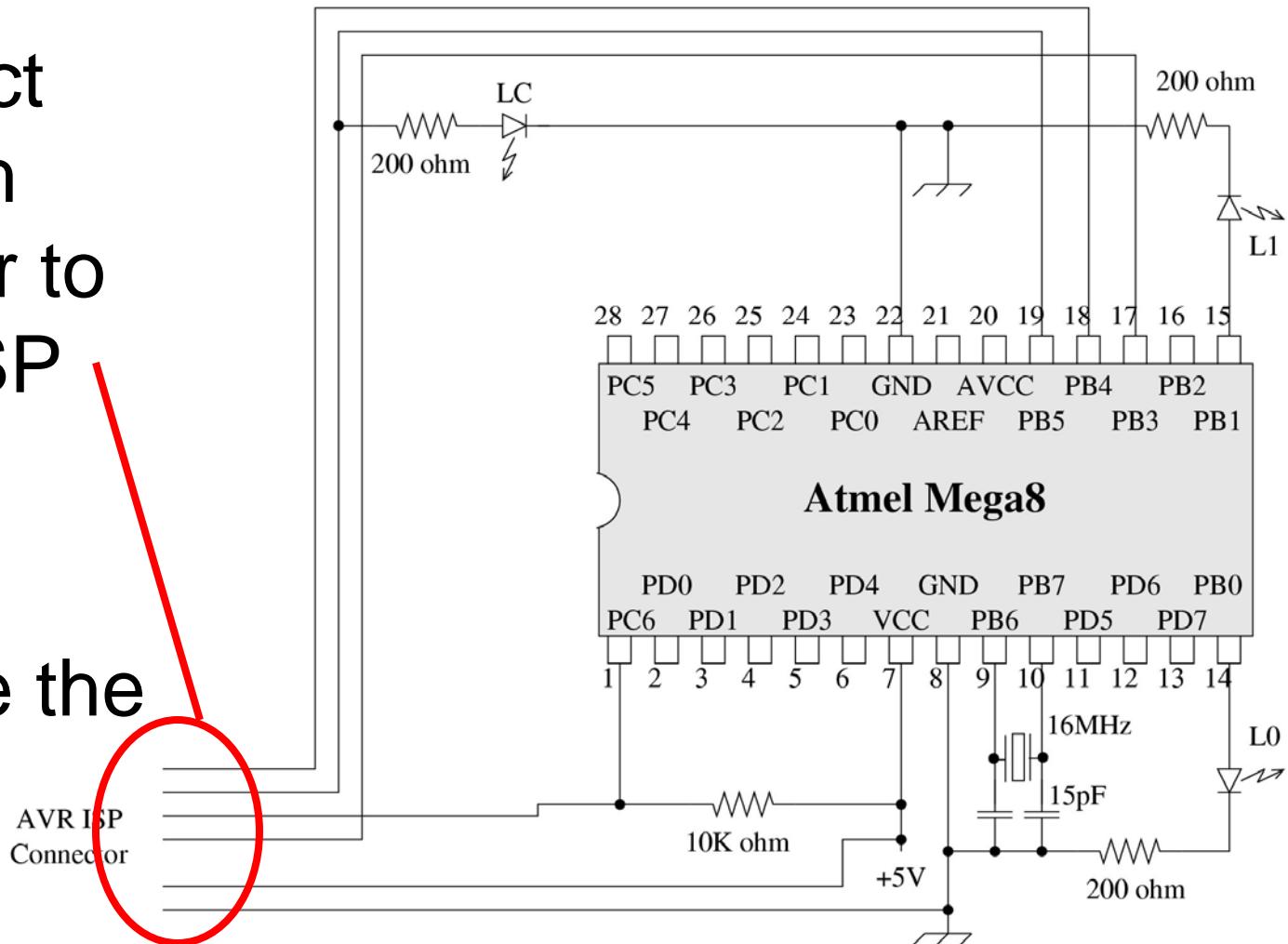
# (Projects 2-4)

# A Basic Circuit



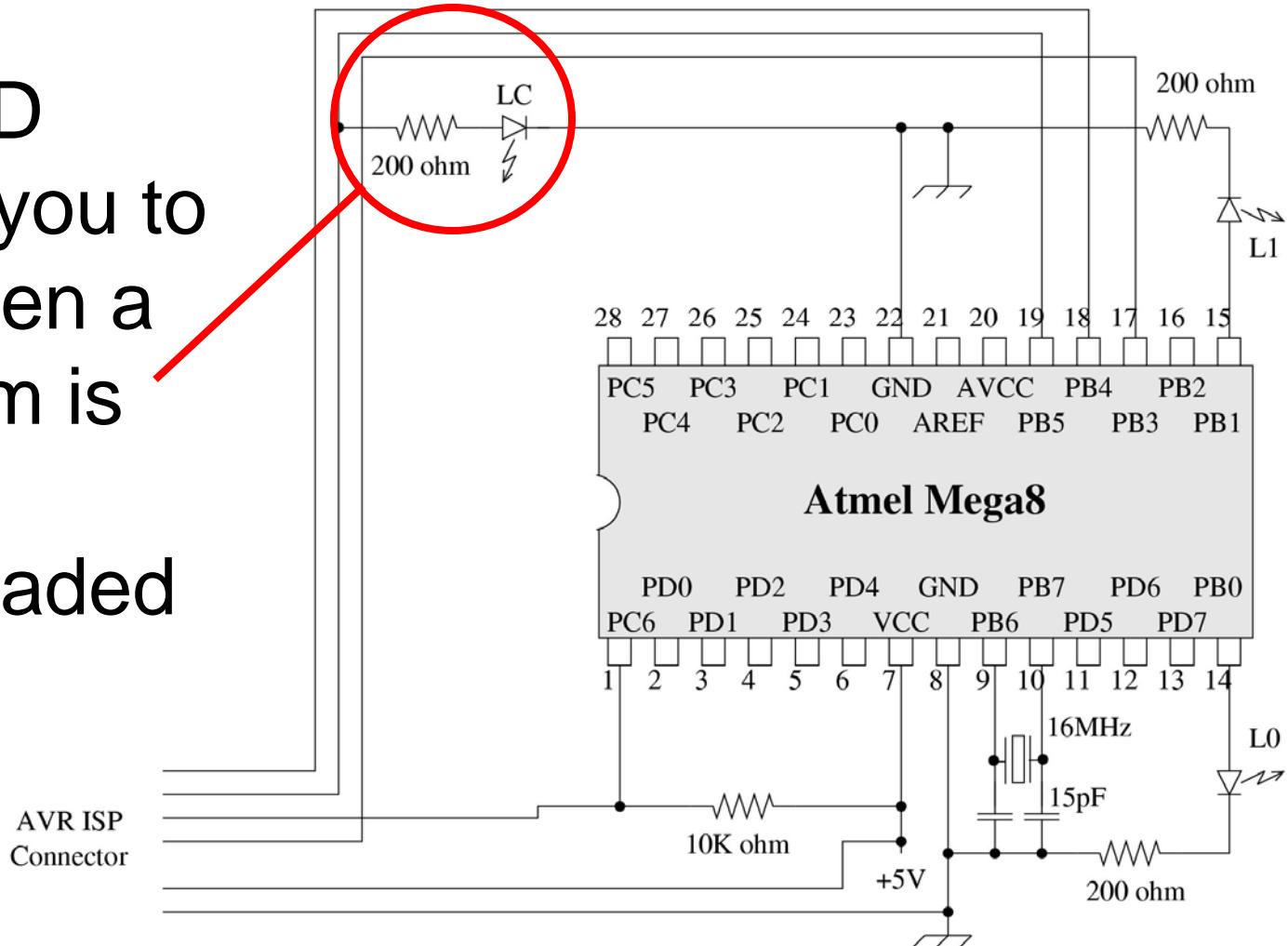
# A Basic Circuit

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



# A Basic Circuit

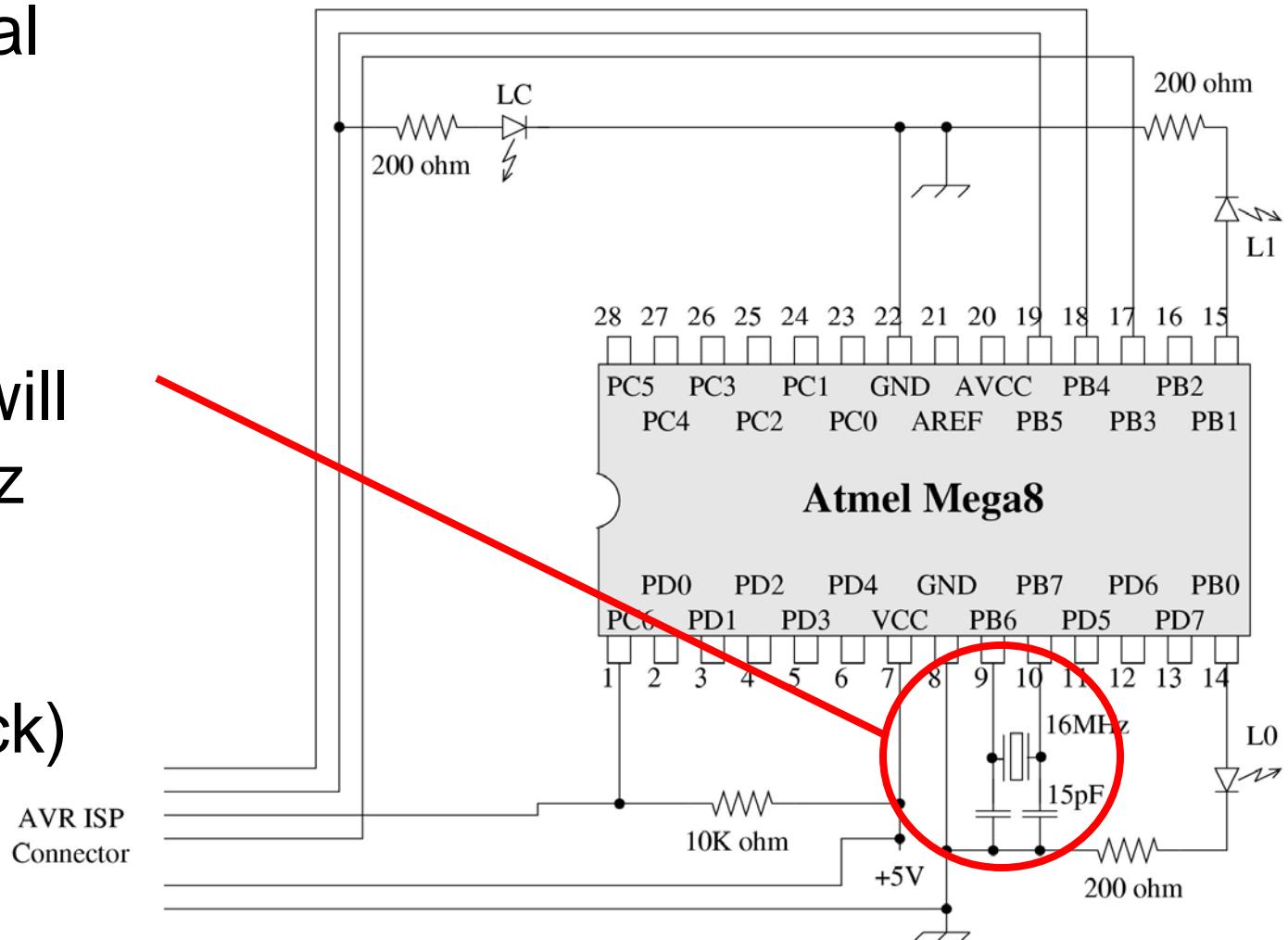
Extra LED  
allows you to  
see when a  
program is  
being  
downloaded



# A Basic Circuit

## 16 MHz crystal

- Optional!
- Without it,  
your  
processor will  
run at 1MHz  
(in general,  
we will use  
16MHz clock)



# Mega8 Wierdnesses

- The programmer relies on the clock being used by the mega8
  - The programmer speed must be no greater than  $\frac{1}{4}$  of this clock (lower is safer)
- Out of “the box,” this clock is the internal one (1 MHz)
  - Set the programmer to operate at  $\sim$ 100KHz
  - Configure the “fuse bits” to use the external crystal
  - Set programmer back to 1-4 MHz

# Configuring the Clocks

AVR Studio (after you are connected to the programmer):

- Programmer frequency:
  - Board menu
  - Set ISP frequency
  - Write
- Chip clock configuration:
  - Fuses menu
  - Select last option: high freq crystal/resonator; 16K CK + 64 ms
  - Program

# Configuring the Clocks

AVRdude users:

- See the Atmel HOWTO

# 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