

# Solderless Breadboards

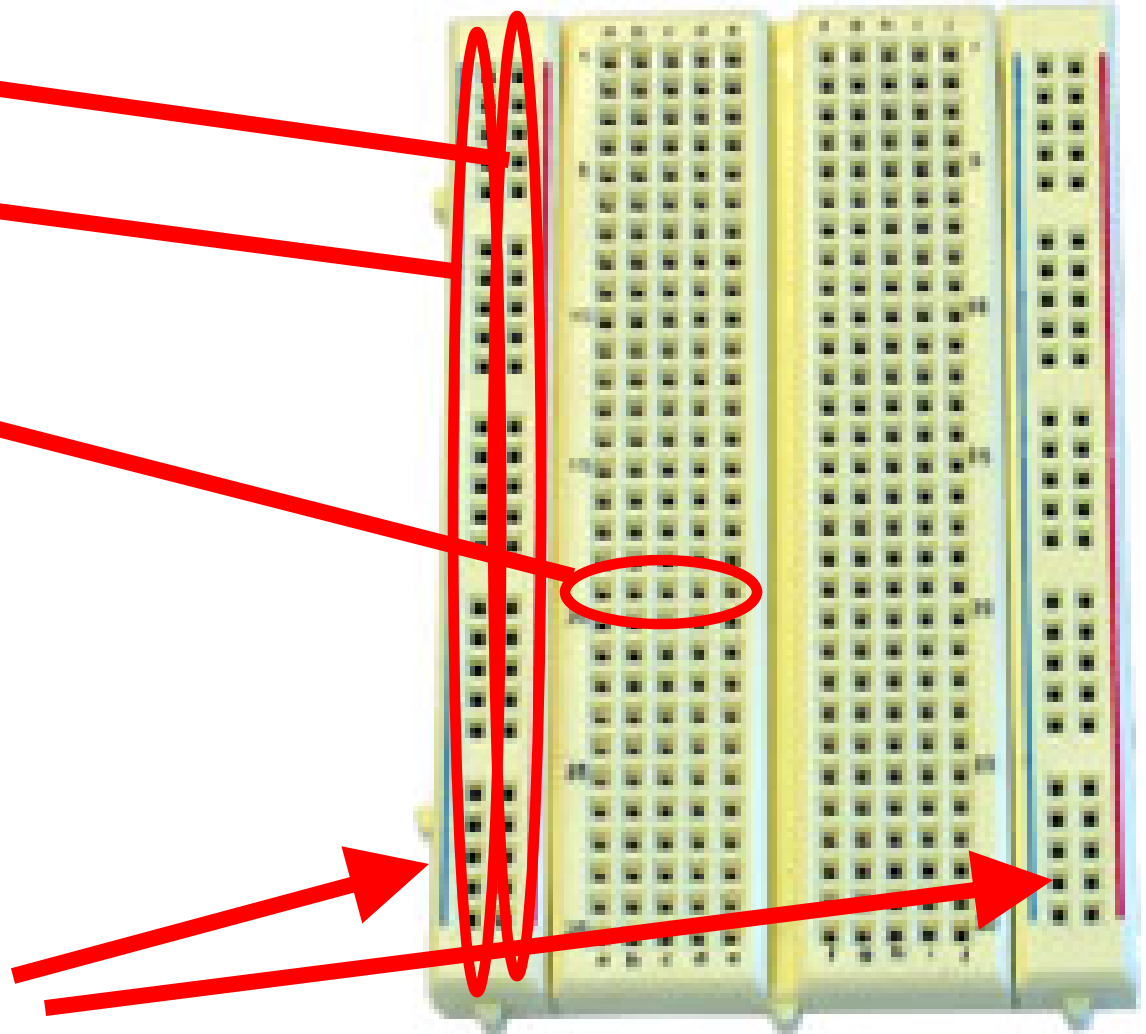
mbus.net

Power bus  
(red)

Ground bus  
(blue)

Component  
bus

Note that the two  
sides are not  
connected



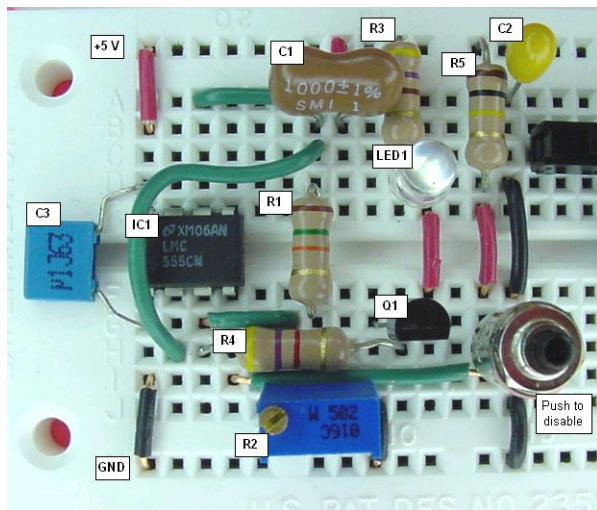
# Wiring Standards

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

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

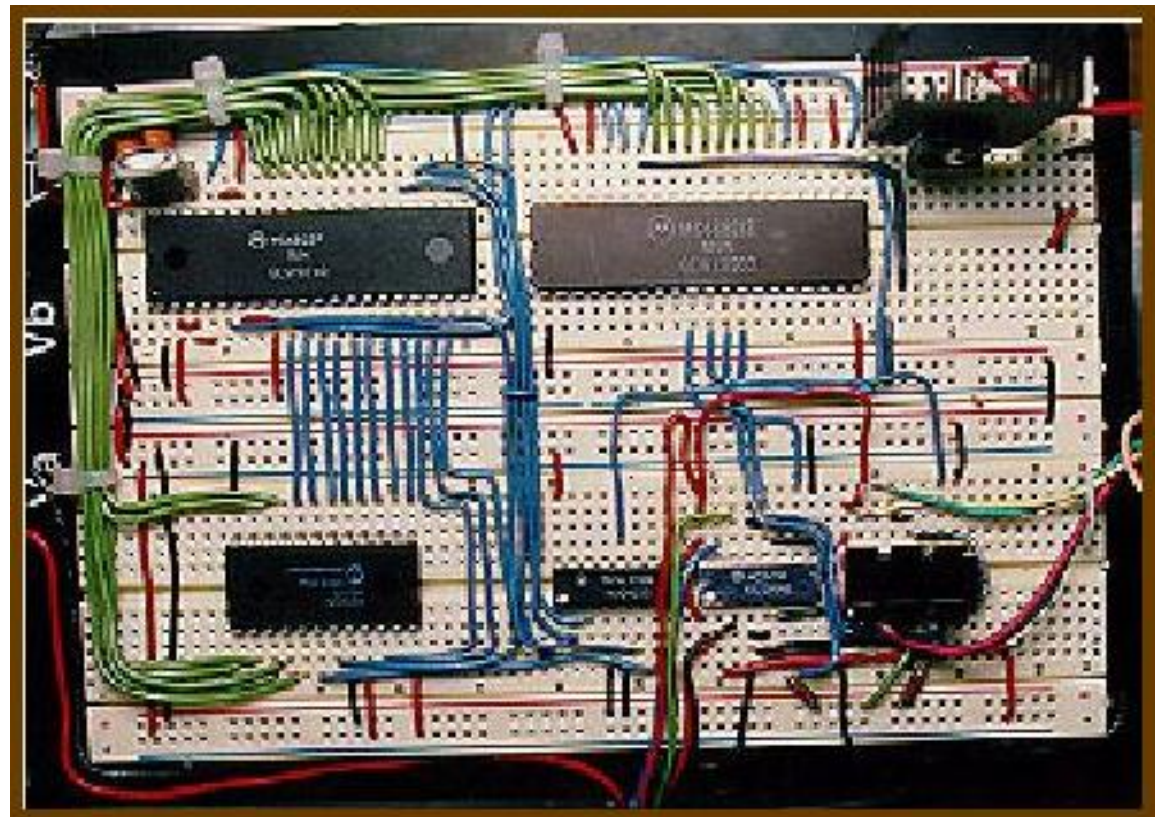
# Clean Wiring

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



[www.linefollowing.com](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

# 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

# Physical Interface for Programming

AVR ISP



# Physical Interface for Programming

AVR ISP

USB

connection to  
your laptop





# Physical Interface for Programming

## AVR ISP

Header connection  
will connect to  
your circuit  
(through an  
adapter)

Be careful when  
you plug your  
circuit in (check  
before powering)



# AVR ISPs are Cranky

- When things are plugged in and powered, you should see two green LEDs on the ISP (on most units)
- One red: usually means that your circuit is not powered
- Flashing orange: connector is backwards!
- Orange: the programmer is confused
  - Could be due to your circuit not being powered at 5V
  - Could be due to other problems
  - Check power and reboot the ISP

# Compiling and Downloading Code

Preparing to program:

- See the Atmel HOWTO
- Install OS-appropriate AVR tools

Do this for Thursday!

# Compiling and Downloading Code

- Once the chip is programmed, the AVR ISP will automatically reset the processor; starting your program

# Hints

- Use LEDs to show status information (e.g., to indicate what part of your code is being executed)
- Remember: on the Arduino boards, there is a LED connected to port B, pin 7
- Have one LED blink in some unique way at the beginning of your program
- Go slow:
  - Implement and test incrementally
  - Insert plenty of pauses into your code (e.g., with `delay_ms()`)

# Getting Hardware Help

- Some exercises in class (come ready)
- Office hours
- Appointments

# 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

# Group Assignments

# Musts For Next Time

- Atmel HOWTO: get your compiler tools installed
  - Even if you are not using Windows, consider using an emulator so you can use AVRstudio
- Subversion: install (see the downloads page)

# Next Time

## First circuit and program

- Come with laptops installed with the necessary AVR packages  
(see the Atmel HOWTO for details)
- Wire up basic Atmel circuit
- First program: flipping LED states