

Solderless Breadboards

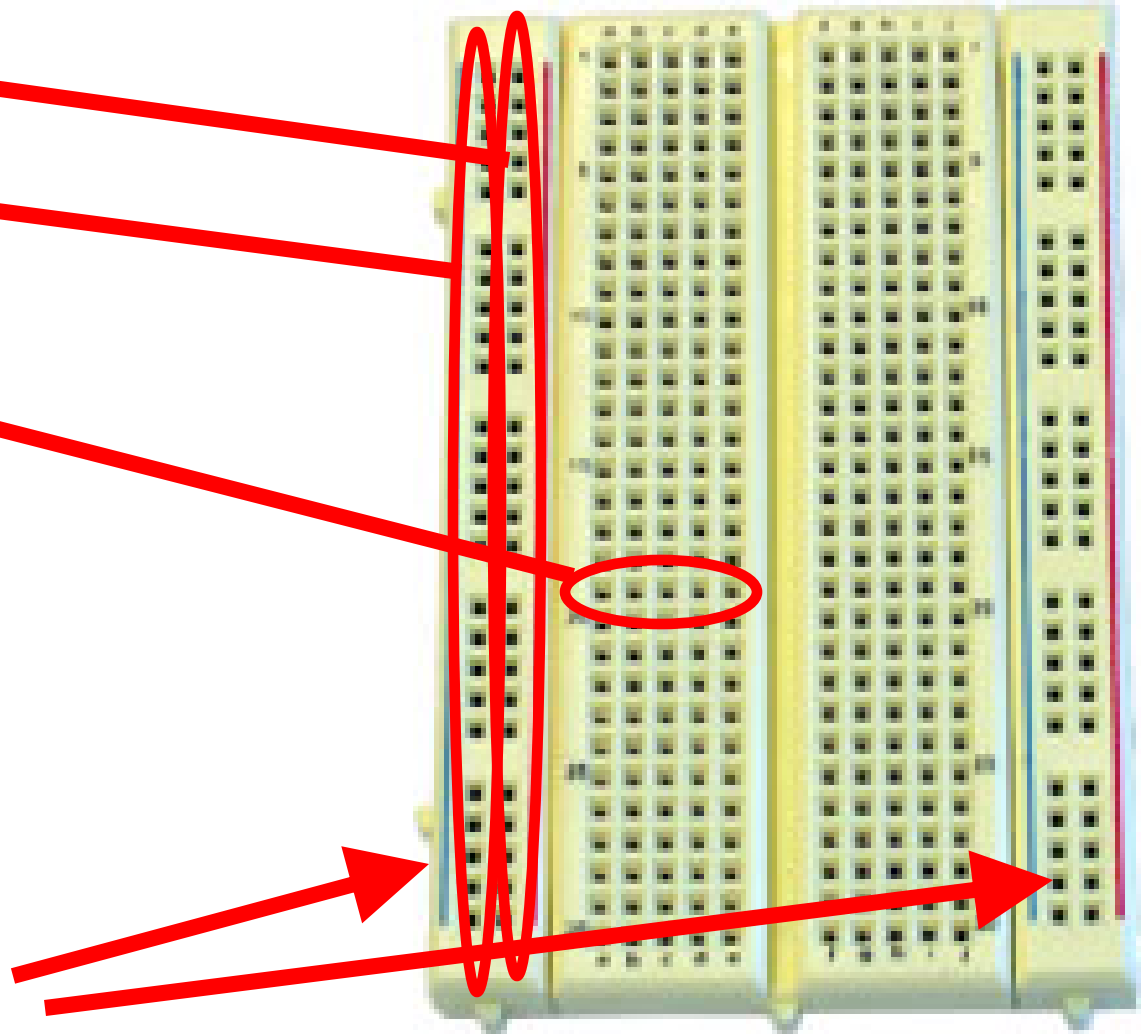
mbus.net

Power bus
(red)

Ground bus
(blue)

Component
bus

Note that the two
sides are not
connected



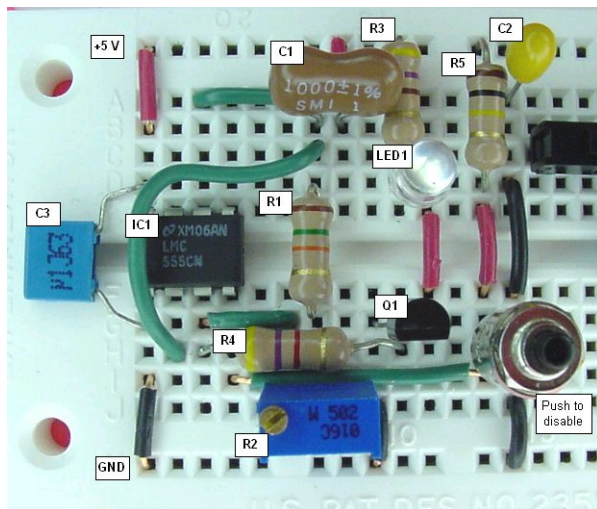
Wiring Standards

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

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

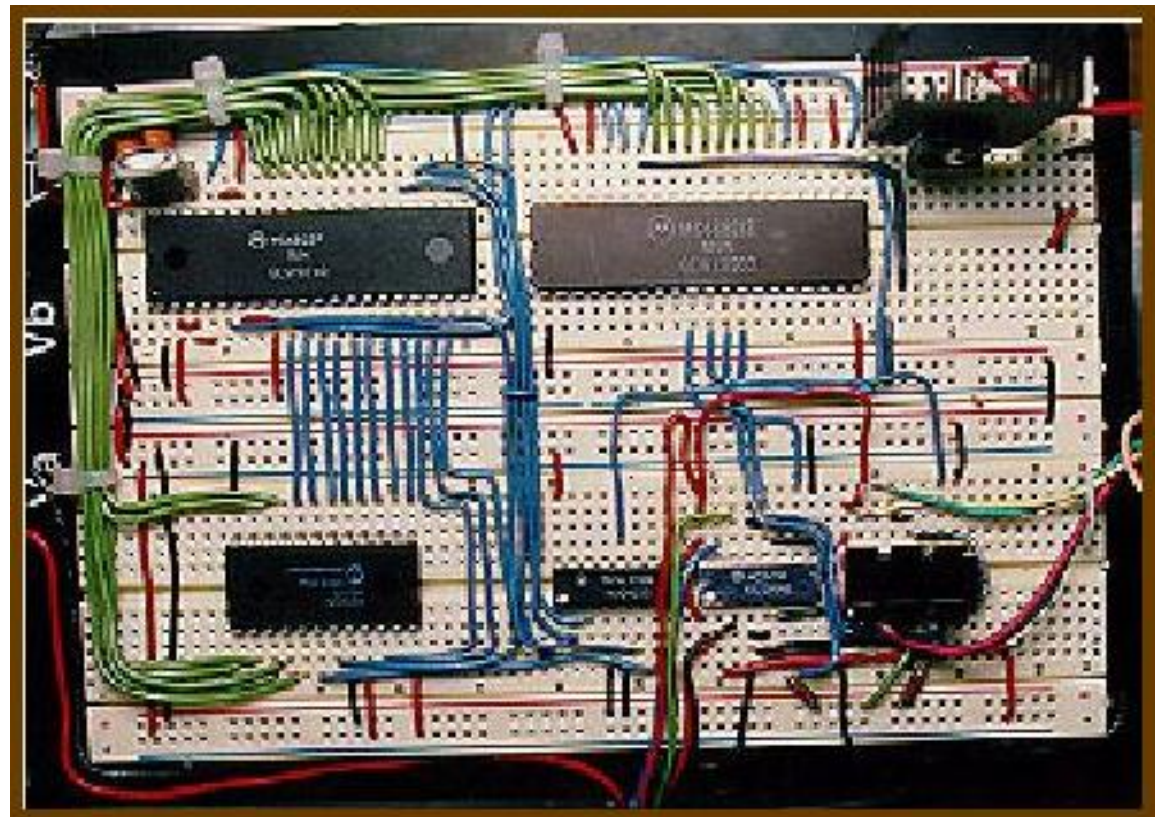
Clean Wiring

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



www.linefollowing.com

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
- 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

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