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
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 use 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

www.dcs.warwick.ac.uk

www2.117.ne.jp
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).
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
• 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 ~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.