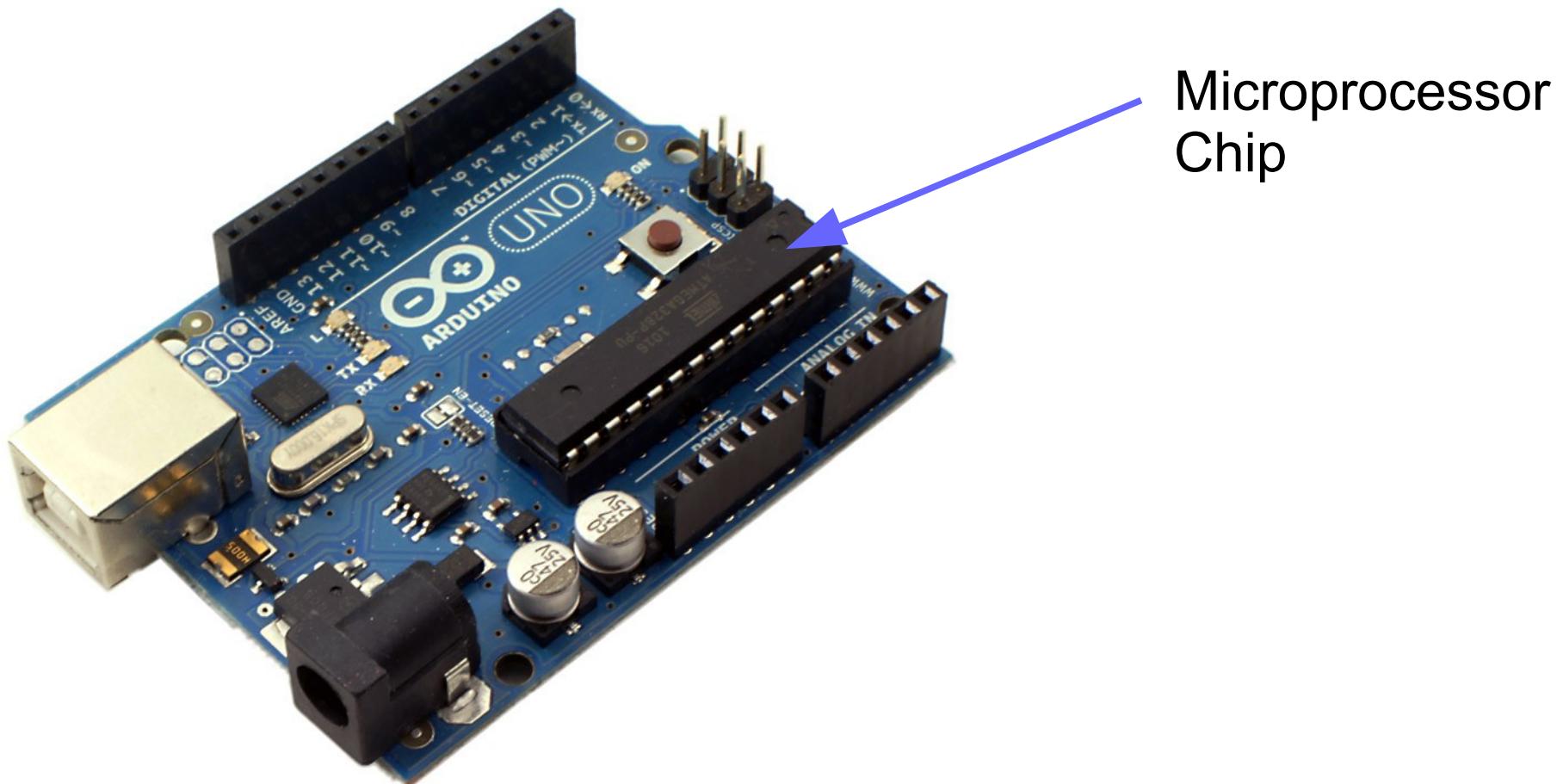


# Robot Wiring Guide

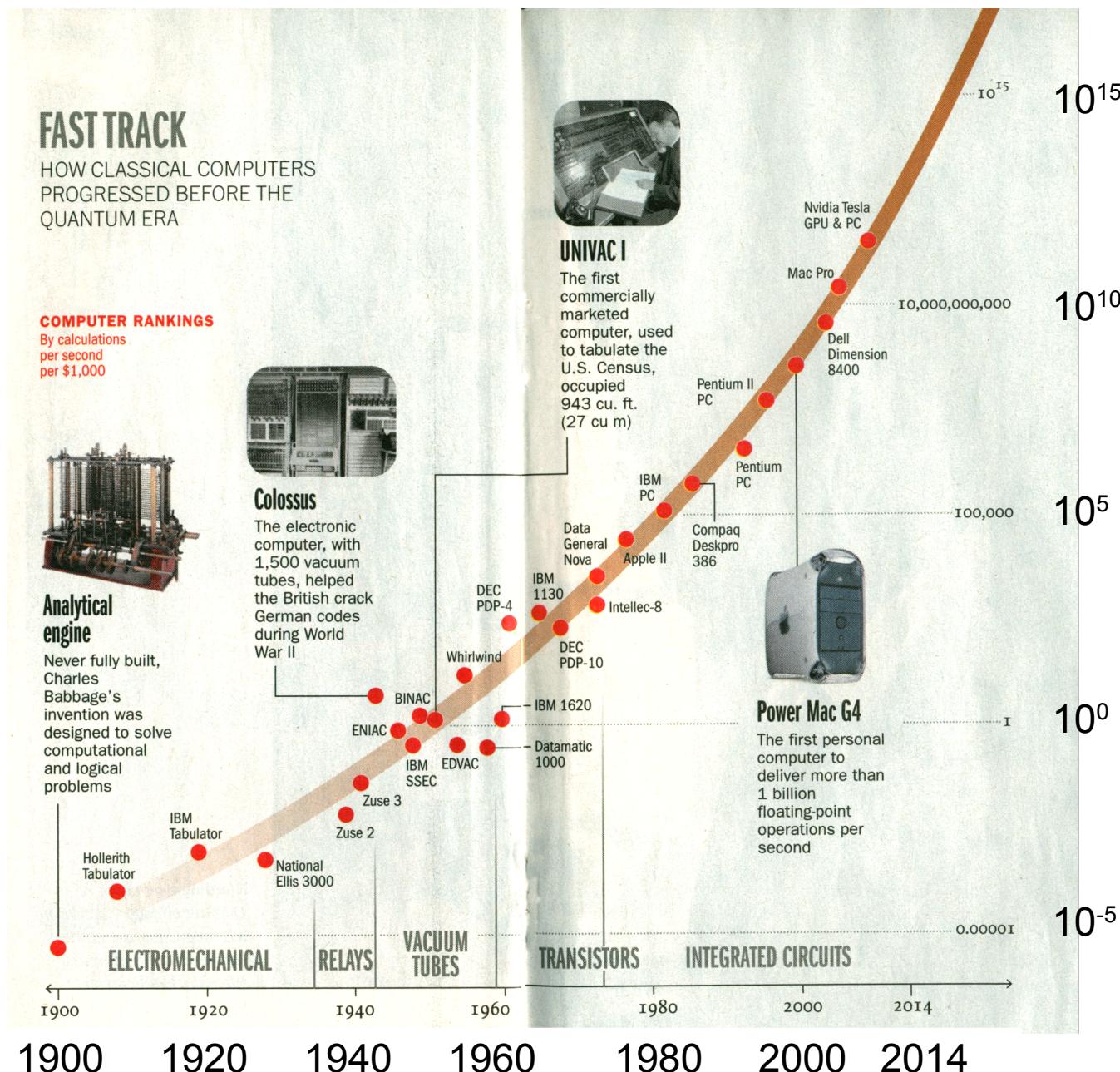
*Or: How to keep from blowing out your  
Arduino Processor*

# Single Board Computer for Robots

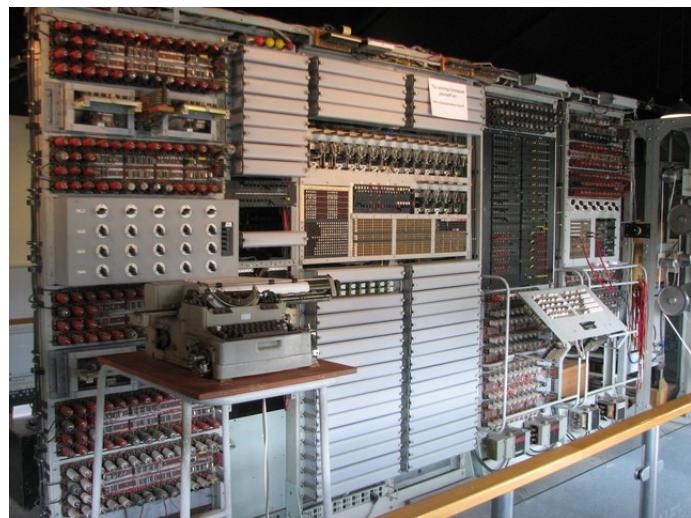


# History of Computational Economy

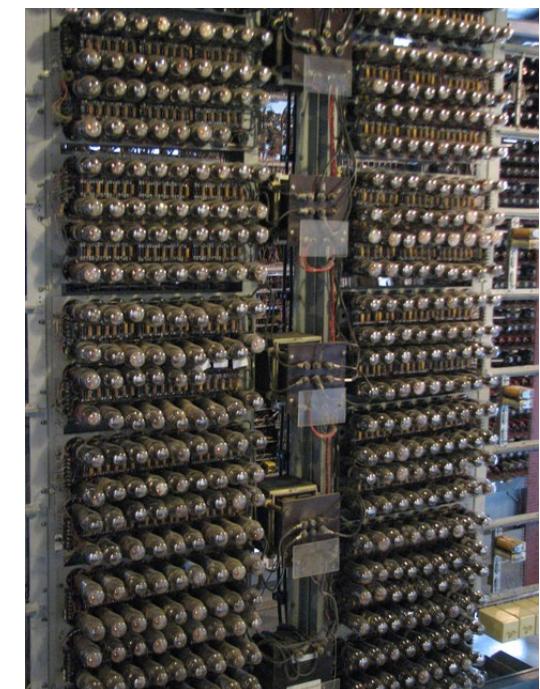
(Time magazine,  
17 Feb 2014)



# The Colossus (circa 1940)



Processor build with thousands of vacuum tubes



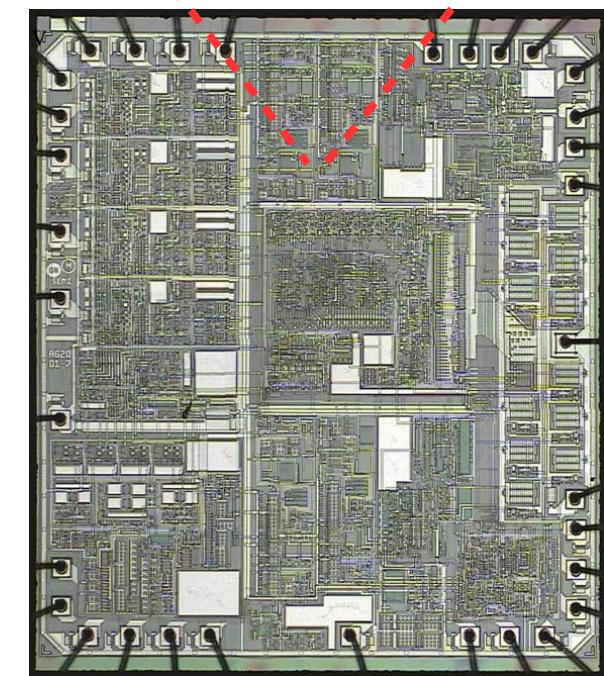
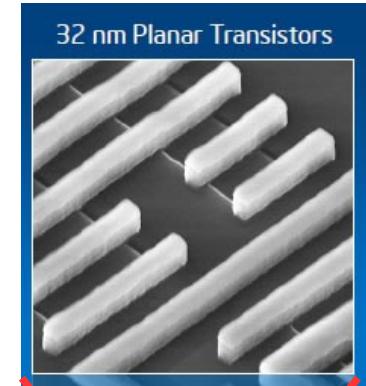
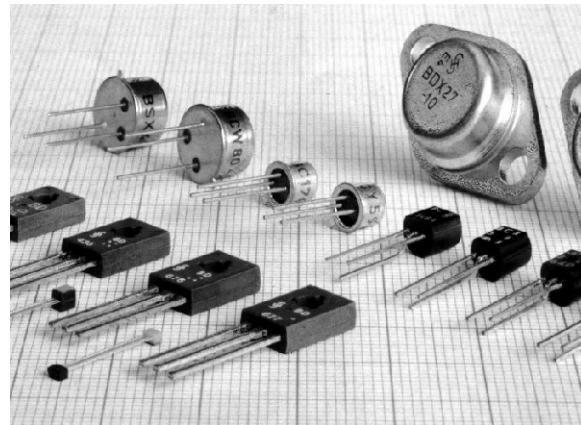
(Reconstruction, displayed at the National Museum of Computing, Bletchley Park, England)

# The IBM 1620 (circa 1960)



First mass produced scientific computer build with thousands of discrete transistors

# Active Device Technology Development



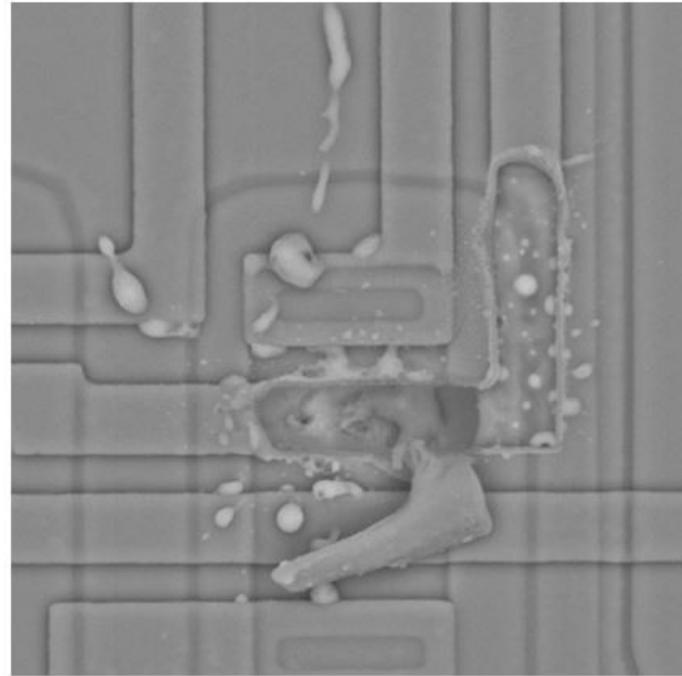
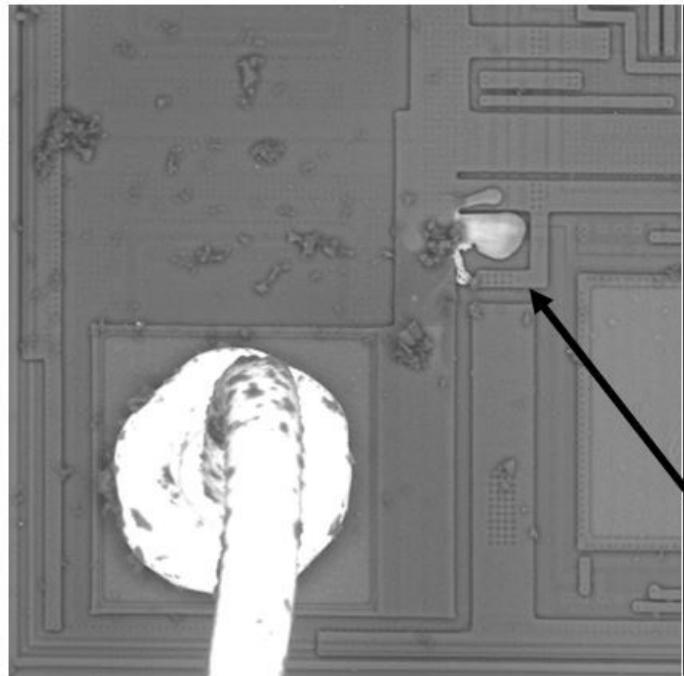
Vacuum Tubes  
~1900 – 1960  
Fairly fault tolerant

Discrete Transistors  
~1960 – 1975  
Not very fault tolerant

Integrated Transistors  
~1975 – present  
Fault intolerant!!!

# Examples of EOS (Electrical Over-Stress)

Failure analysis photos:



Excessive voltage across or current through transistors and other components can blow them out, leaving the chip partially or totally useless

# Single Board Computer for Robots

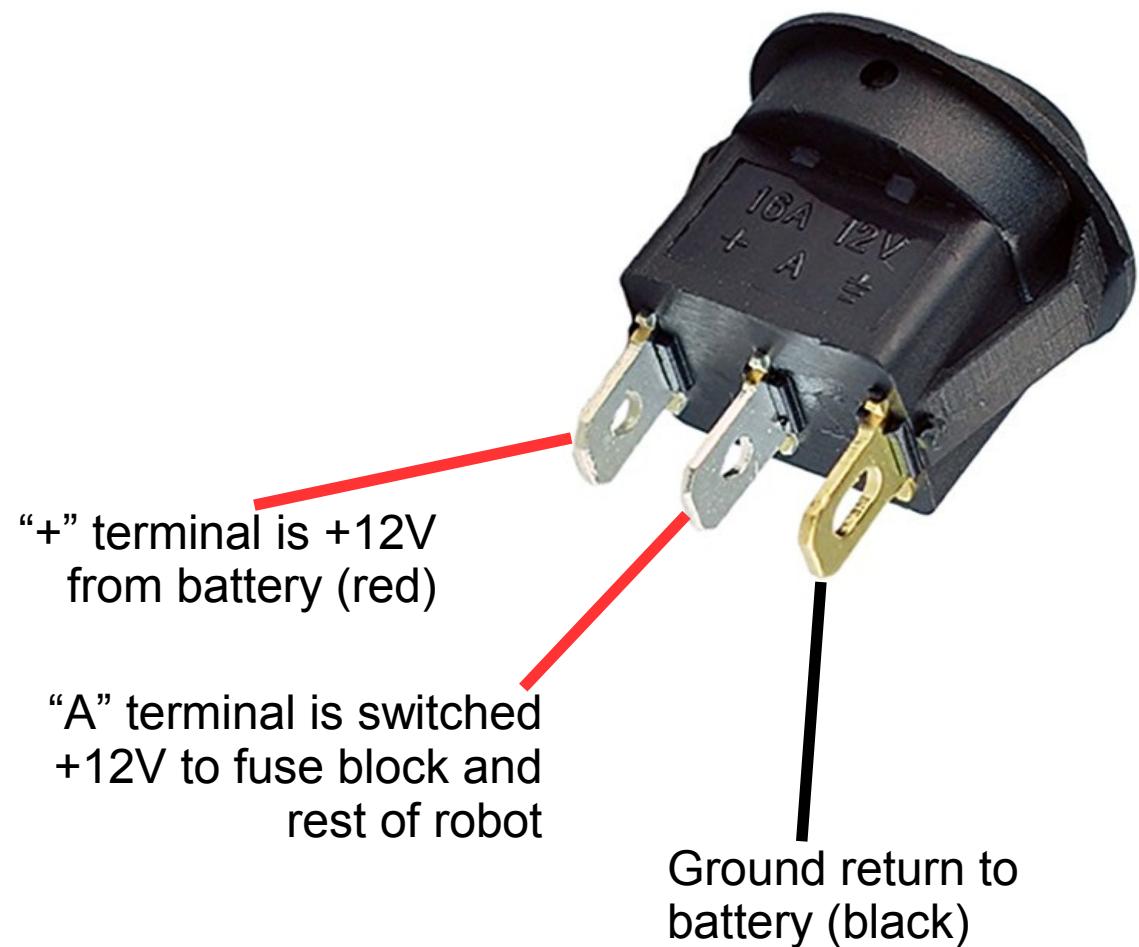


We must use a power switch to protect transistors integrated on the microprocessor chip from burning out in the presence of incidental wire contacts or accidental wiring errors

# Power Switch Details

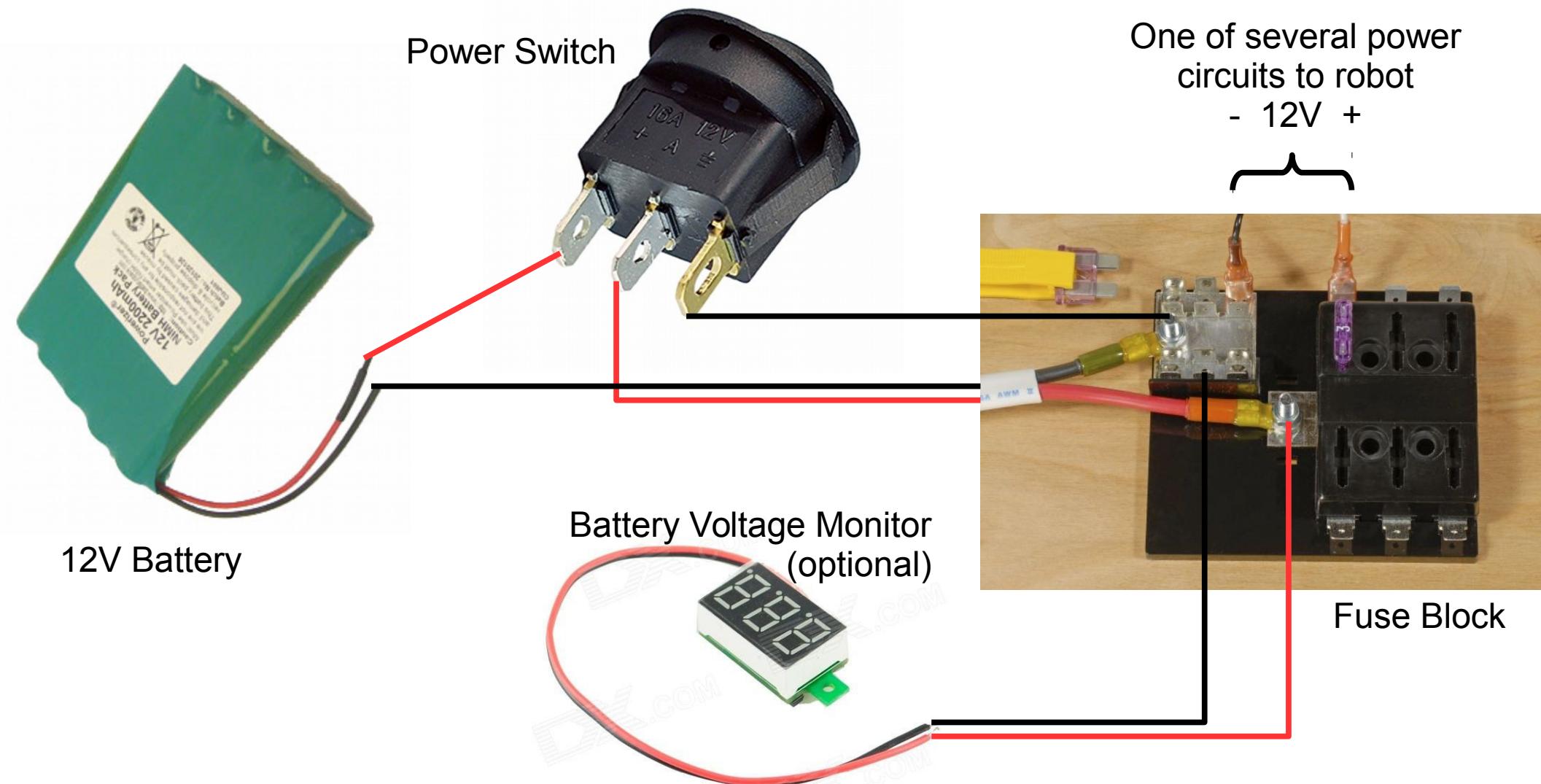


Blue LED is lit when power is switched on

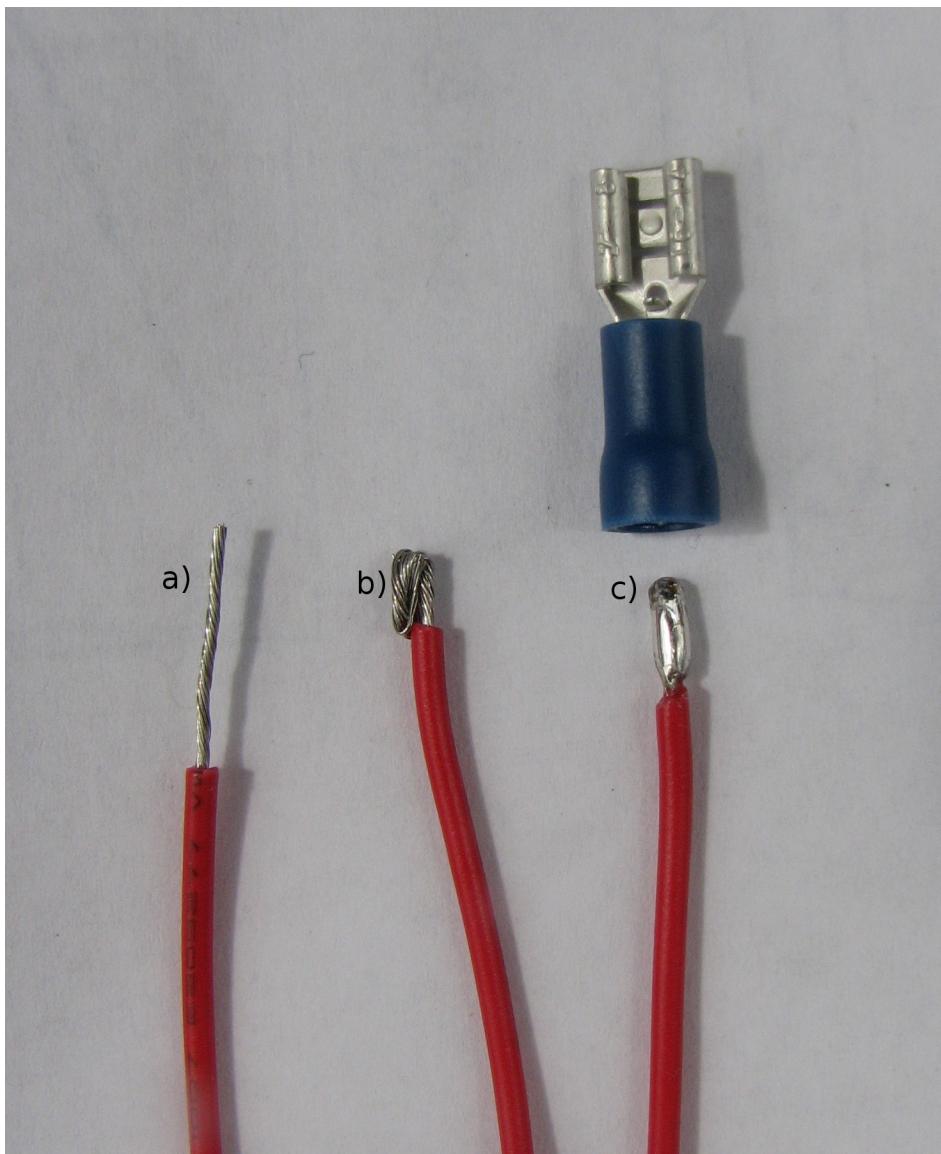


Ground return to battery (black)

# Robot Power Wiring



# Adapting Small Wires to Crimp Terminals



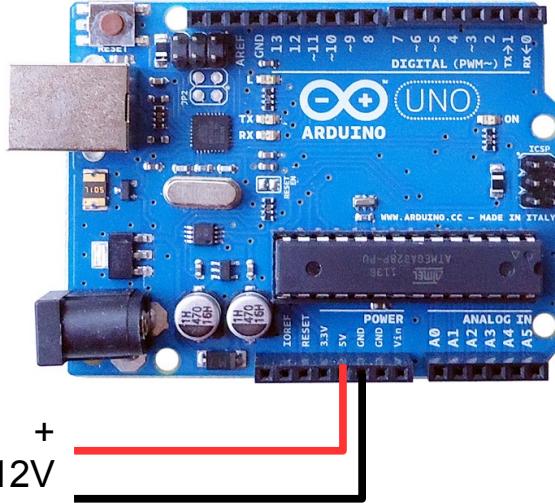
- a) Strip about 1/2 inch of insulation from the small diameter wire
- b) Bundle the wire over with three or four 180 degree twists with needle-nosed pliers
- c) Cover the end with a glob of solder, insert this expanded wire into crimp terminal and crimp tightly

# Safe Wiring Rules

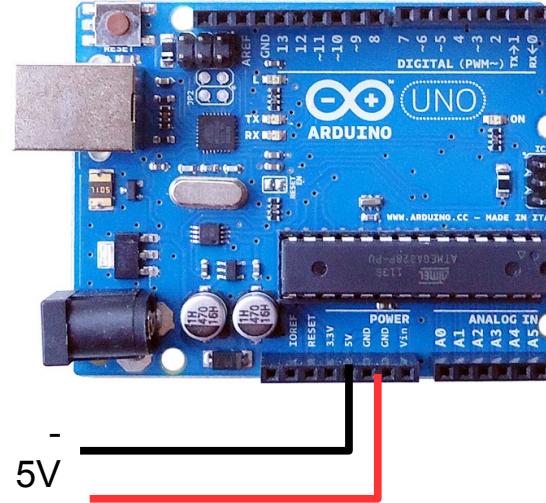
- 1) Turn the power switch off **and** unplug USB cable from laptop  
**before you add or move any wire**
- 2) Don't turn the power switch back on **until the new wiring is double-checked**, preferably by someone else (Hint: Keep your wiring orderly, color-coded, and tied down to the frame of your robot)

# How To Blow Out Your Arduino

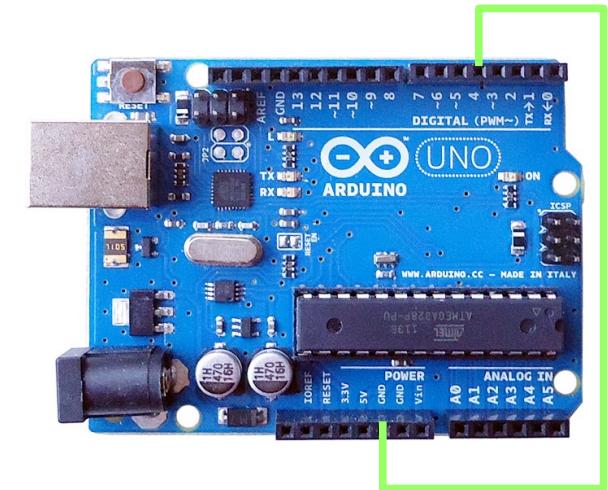
Any time your electrical system is powered up by the battery or *through the USB port*:



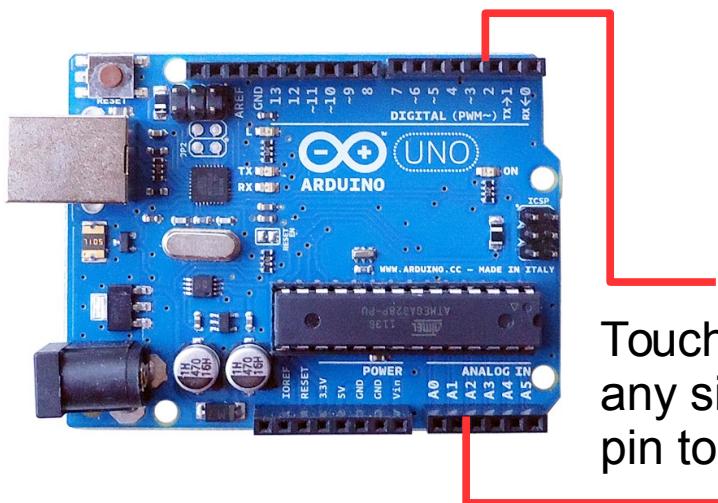
Running 12V from the fuse block directly into the 5V power pins



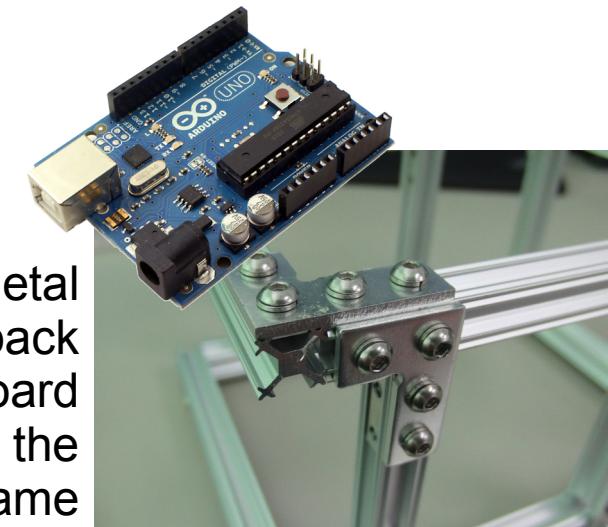
Reversing power polarity into the 5V power pins



Short circuiting a digital output to the ground pin or +5V



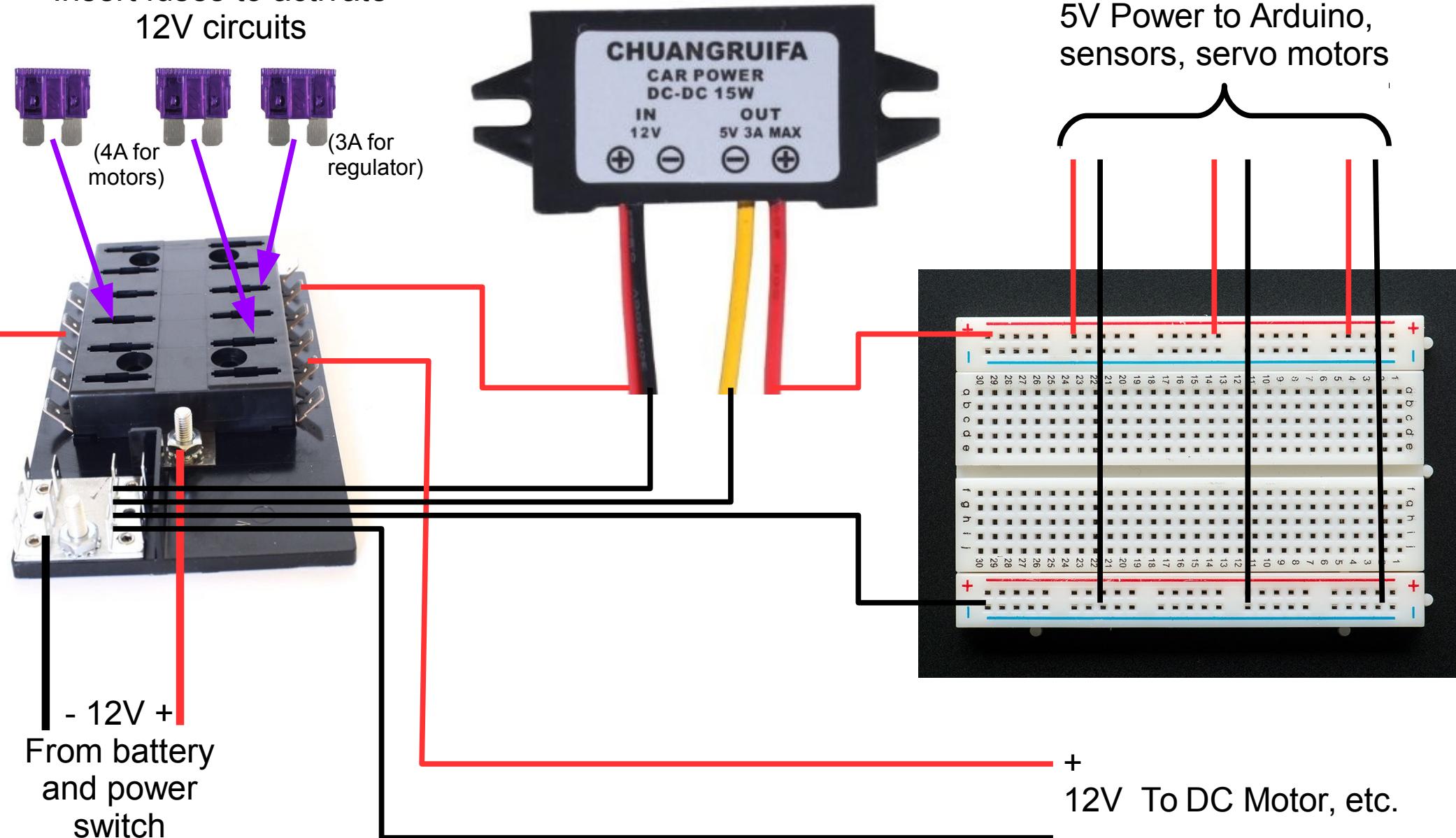
Touching any signal pin to +12V



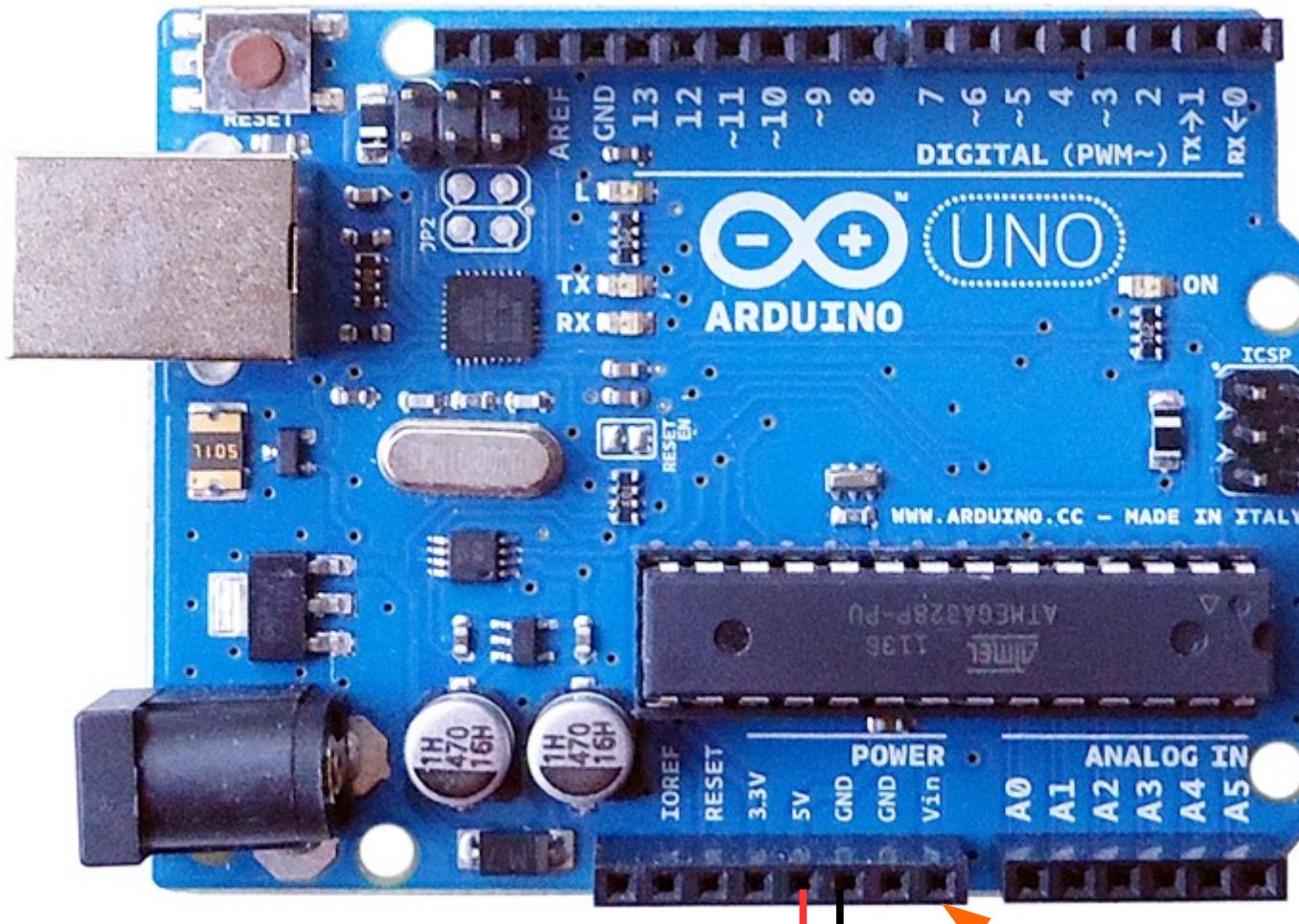
Letting the metal traces on the back side of the board short circuit to the microrax frame

# Wiring the 5V Regulator and Breadboard

Insert fuses to activate  
12V circuits



# Powering the Arduino

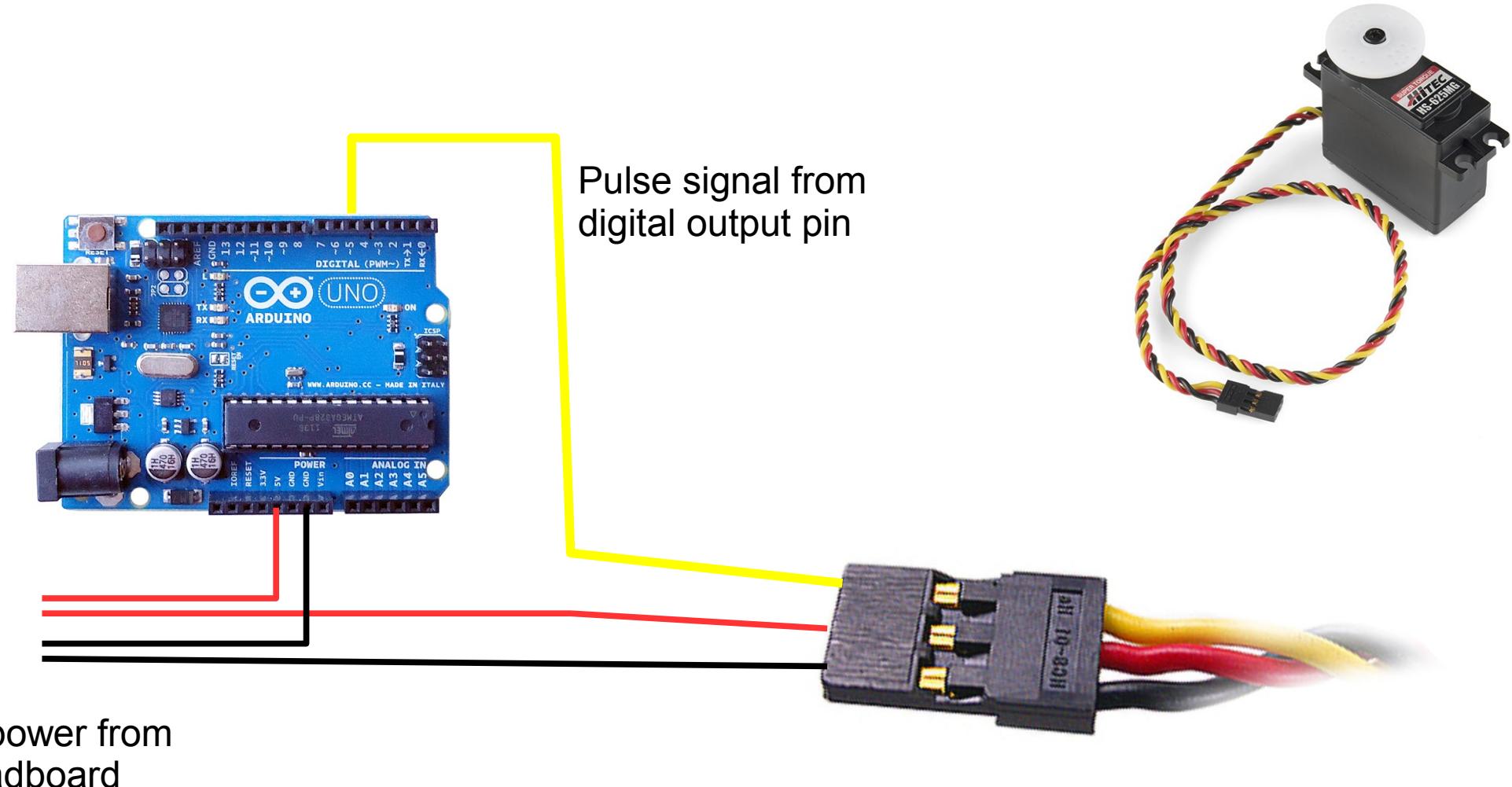


5V power from  
breadboard *must* be  
wired into the “5V” pin

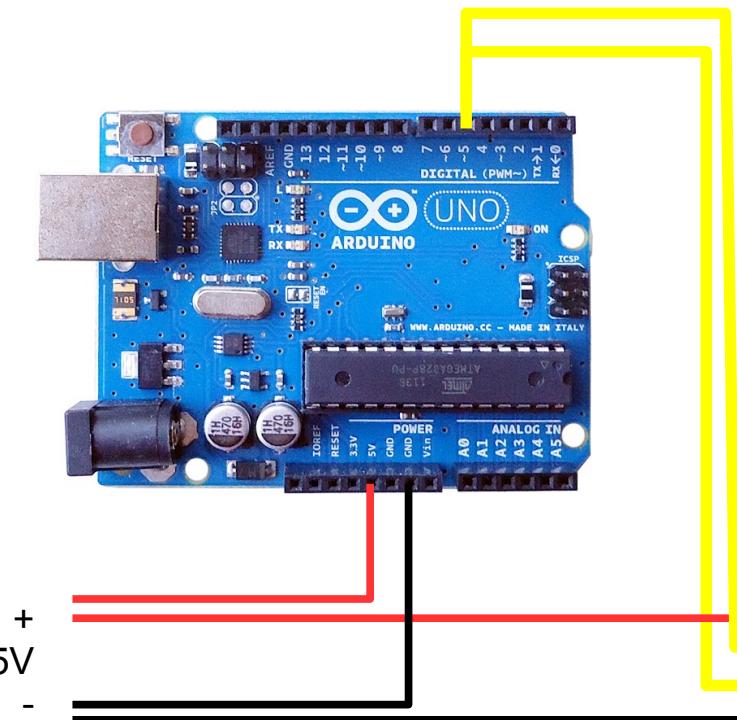


Important! Leave  
the VIN pin  
disconnected!!

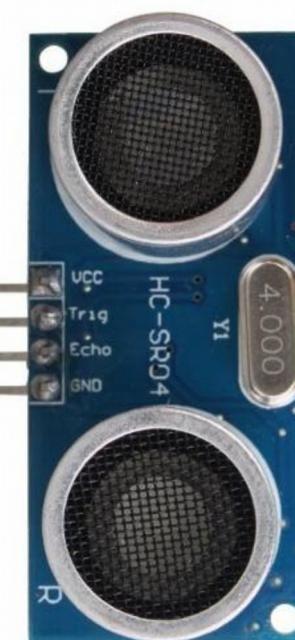
# Wiring Servo Motors



# Wiring Ping Distance Sensors



Pulse signals to and from same digital pin



5V power from breadboard

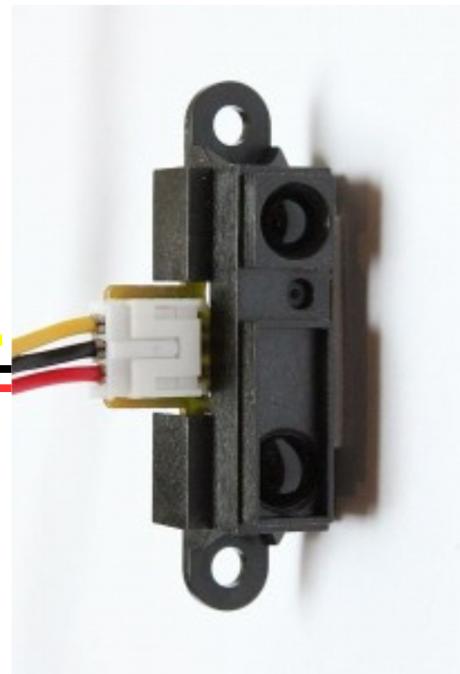
# Wiring IR Distance Sensors



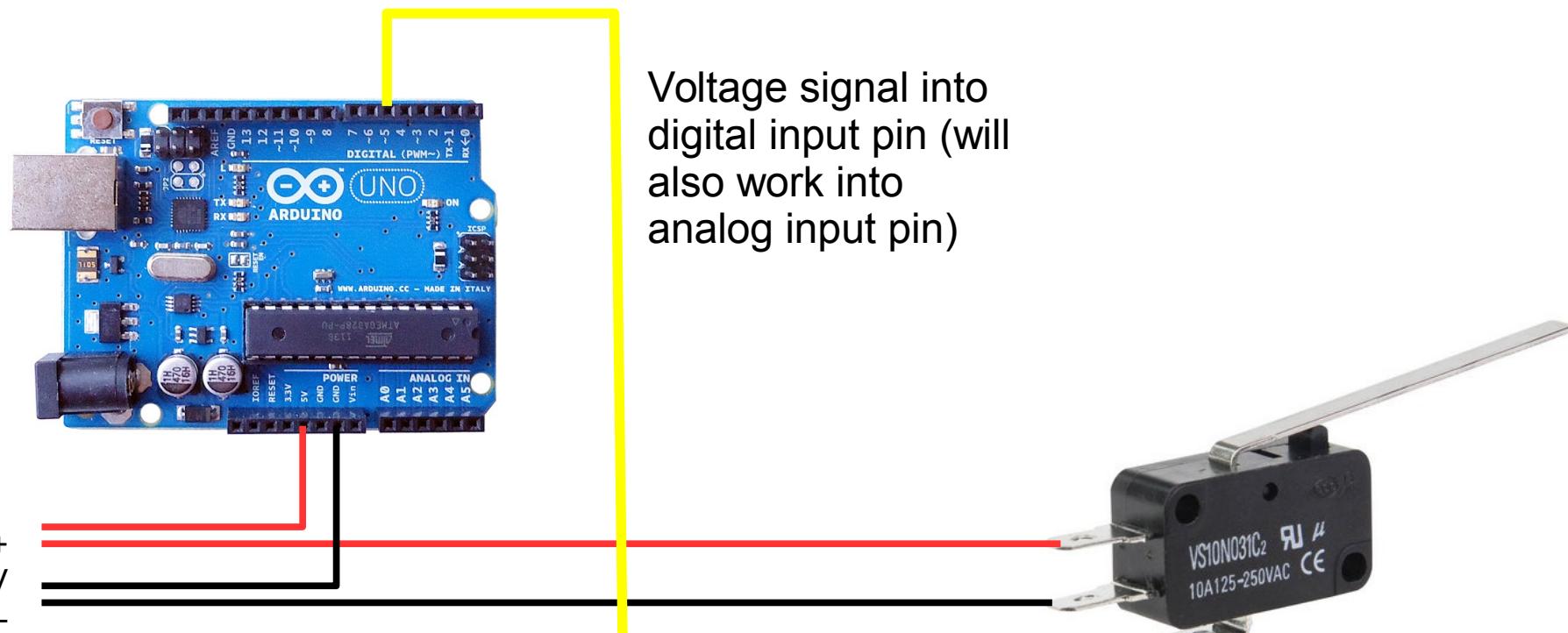
Voltage signal into  
analog input pin

+  
5V  
-

5V power from  
breadboard

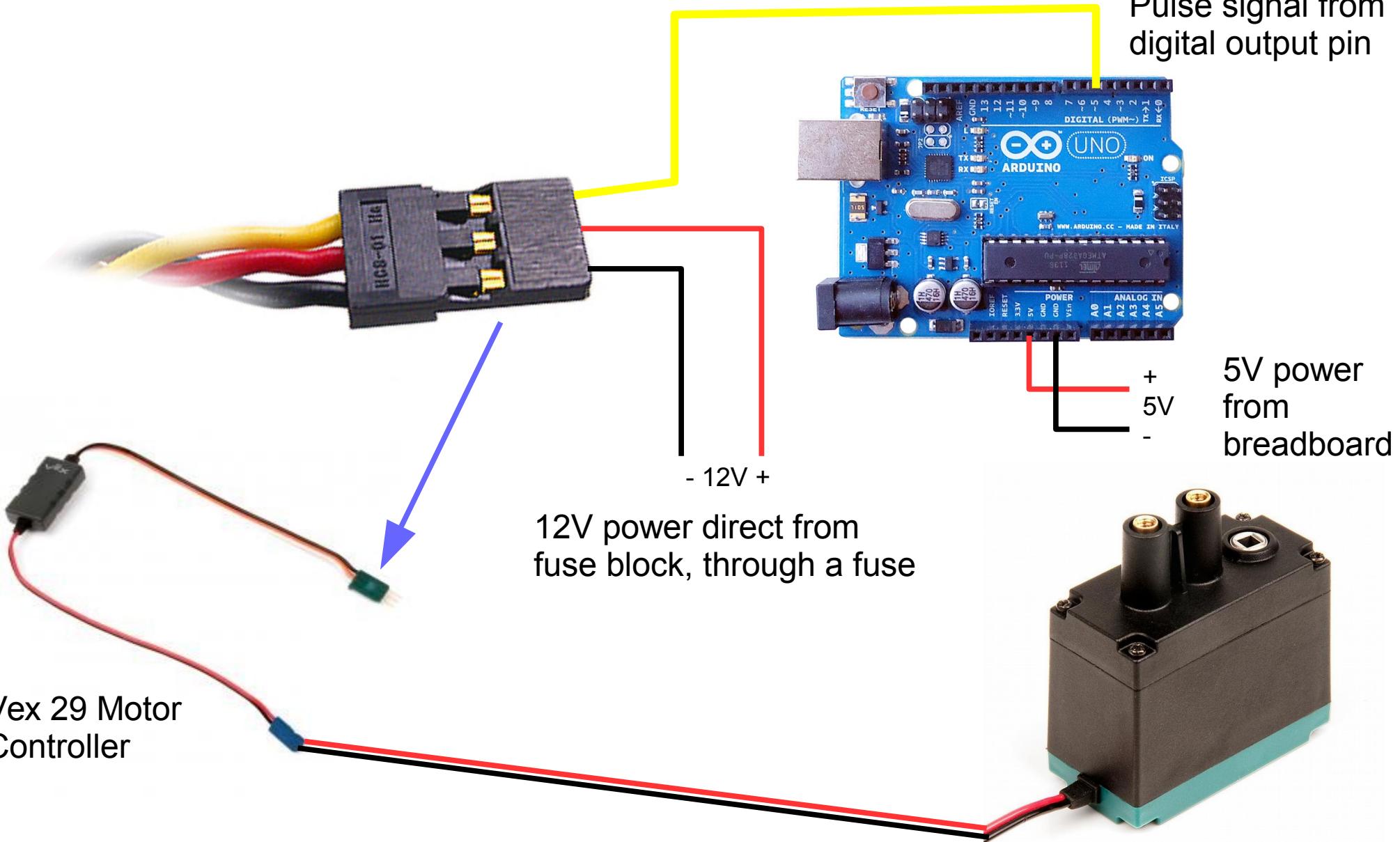


# Wiring Bump Sensors



5V power from  
breadboard

# Wiring DC Drive Motors



Vex 29 Motor  
Controller