



# 2.017 DESIGN OF ELECTROMECHANICAL ROBOTIC SYSTEMS

*Fall 2009 Lab 1*

September 14, 2009

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## 1. Microcontrollers

- Introduction to microcontrollers
- Arduino microcontroller kit

## 2. Sensors and Signals

- Analog / Digital sensors
- Data acquisition
- Data processing and visualization

## 3. GPS and Data Logging

- GPS receiver and shield
- Data logging
- Visualization of data

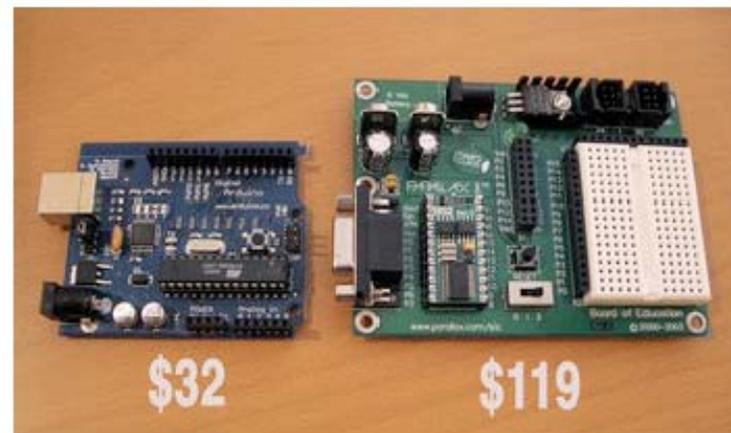
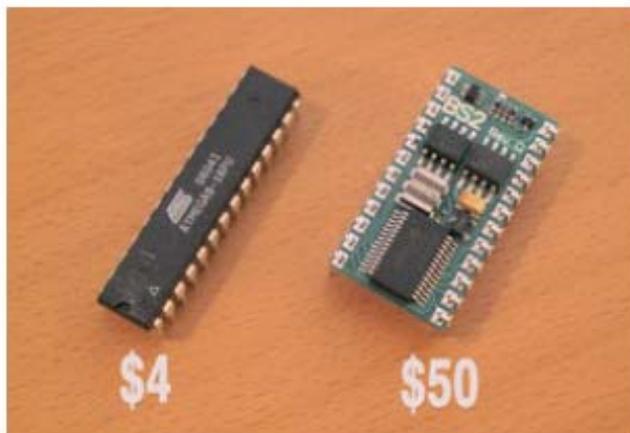
## 4. Motor Control

- Motors
- Encoders
- Position control

# Why Arduino



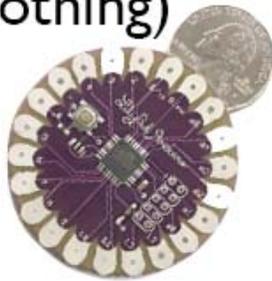
- Popular
- Open source
- Low cost
- Large user community
- Easy to use development environment



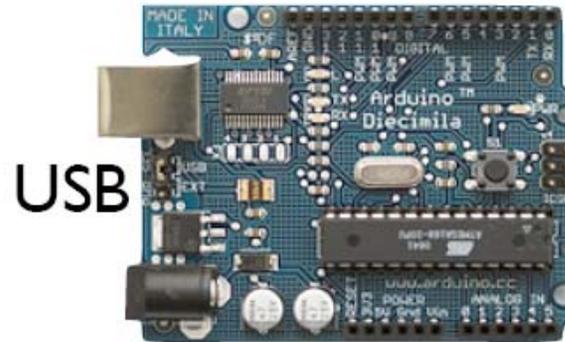
# Arduino Hardware



LilyPad  
(for clothing)

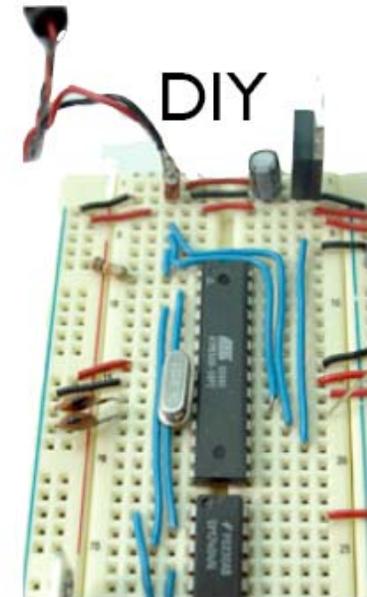


Photos by SparkFun Electronics.

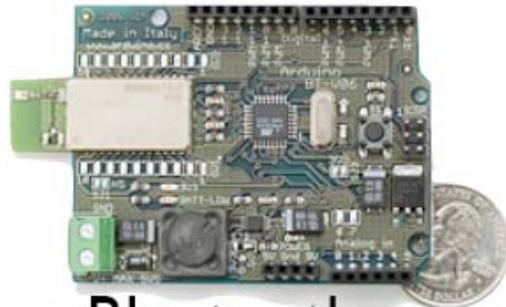


USB

Photos by SparkFun Electronics.



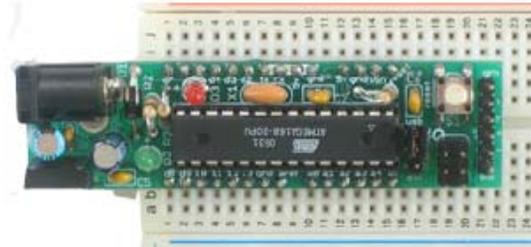
DIY



Bluetooth

Photos by SparkFun Electronics.

Boarduino Kit



Courtesy of Adafruit Industries. Used with permission.

“Stamp”-sized



Photos by SparkFun Electronics.

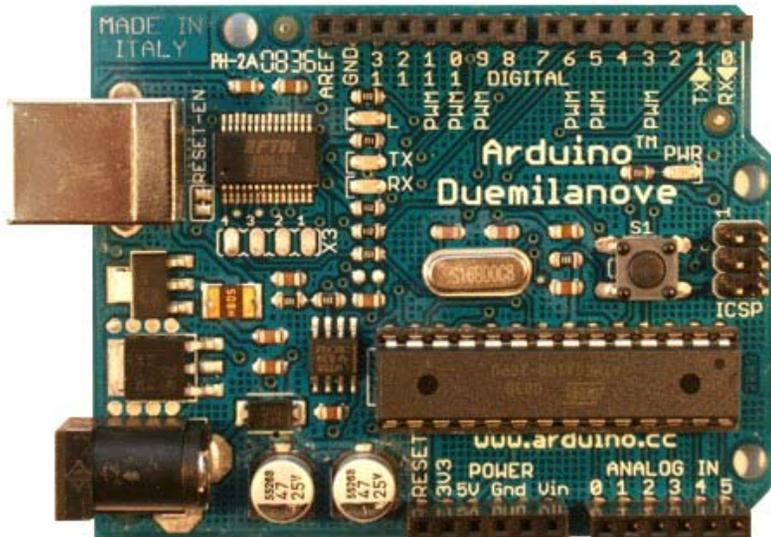
many different variations to suite your needs

<http://todbot.com/>

# Arduino Duemilanove Microcontroller



<http://www.arduino.cc/>

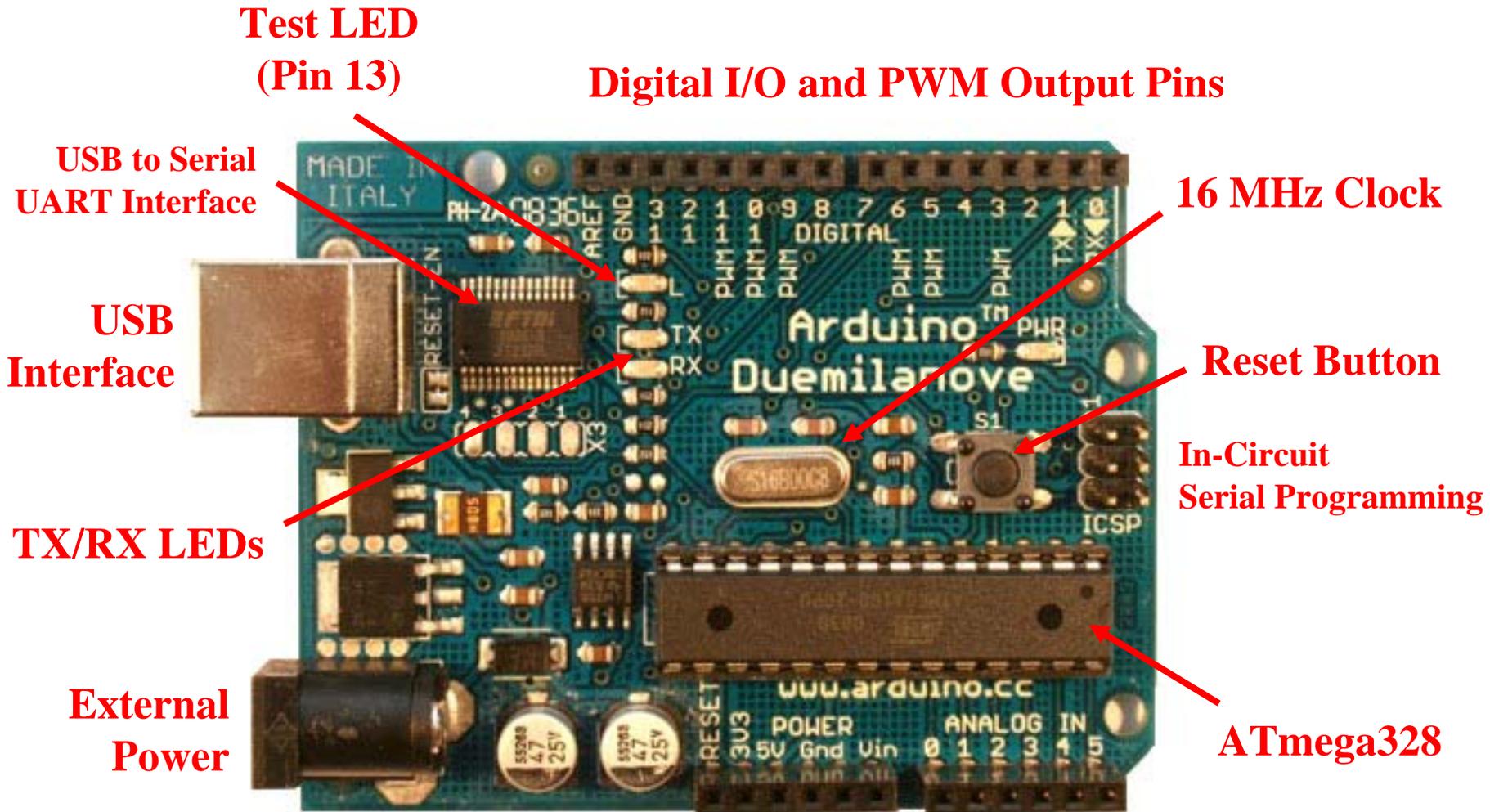


Courtesy of Arduino.cc. Used with permission.

Expandable by stacking add-on modules for data storage, wireless, GPS, audio, motor drive,... etc.

Microcontroller	8-bit ATmega328 (by ATMEL)
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 2 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

# Arduino Components



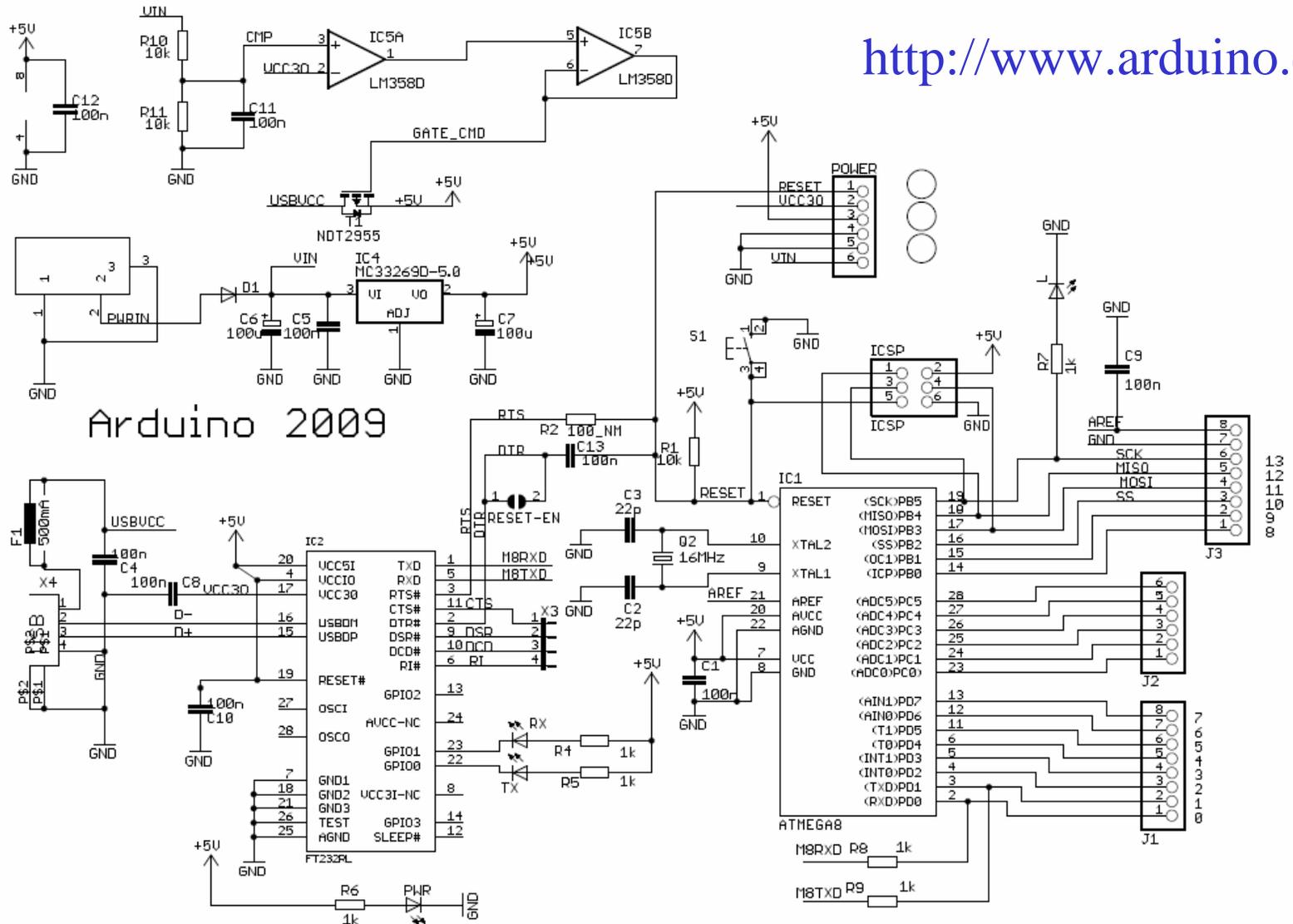
Courtesy of Arduino.cc. Used with permission.

**Power Pins**      **Analog Input Pins**

# Arduino Circuit Diagram



<http://www.arduino.cc/>



# Arduino Programming Environment



- Open source
- Simplified C++ like development environment that is easy to program and to upload the code
- Several examples are included that demonstrate various I/O capabilities
- Built-in libraries that simplify data I/O tasks
- Large user community



# Resources



- <http://arduino.cc/>
- <http://ladyada.net/learn/arduino/>
- <http://todbot.com/blog/category/arduino/>
- <http://freeduino.org/>
- <http://adafruit.com/>
- <http://sparkfun.com/>
- Books:
  - “Arduino Programming Notebook”, Brian W. Evans
  - “Physical Computing”, Dan O’Sullivan & Tom Igoe
  - “Making Things Talk”, Tom Igoe
  - “Hacking Roomba”, Tod E. Kurt

# Labs 1 & 2: The Arduino Kit Experiments



- {CIRC01} Getting Started - (Blinking LED)
- {CIRC02} 8 LED Fun - (Multiple LEDs)

**Lab 1**

- {CIRC03} Spin Motor Spin - (Transistor and Motor)
- {CIRC04} A Single Servo - (Servos)
- {CIRC05} 8 More LEDs - (74HC595 Shift Register)
- {CIRC06} Music - (Piezo Elements)

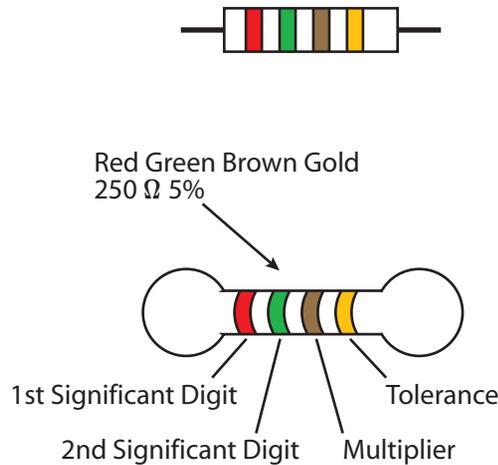
- {CIRC07} Button Pressing - (Pushbuttons)
- {CIRC08} Twisting - (Potentiometers)

**Lab 1**

- {CIRC09} Light - (Photo Resistors)
- {CIRC10} Temperature - (TMP36 Temperature Sensor)
- {CIRC11} Larger Loads - (Relays)

**Lab 2**

# Resistor Color Code Chart



Color	1st-band Digit	2nd-band Digit	3rd-band Digit	4th-band Digit
Black	0	0	$10^0 - 1$	
Brown	1	1	$10^1 - 10$	1%
Red	2	2	$10^2 - 100$	2%
Orange	3	3	$10^3 - 1000$	3%
Yellow	4	4	$10^4 - 10000$	4%
Green	5	5	$10^5 - 100000$	
Blue	6	6	$10^6 - 1000000$	
Violet	7	7	$10^7 - 10000000$	
Gray	0	0	$10^8 - 100000000$	
White	9	9	$10^9 - 1000000000$	
Gold				5%
Silver				10%
None				20%

red green brown gold  
250 Ω 5%

Figure by MIT OpenCourseWare.

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<http://ocw.mit.edu>

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Fall 2009

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