2.017 DESIGN OF ELECTROMECHANICAL ROBOTIC SYSTEMS

Fall 2009 Lab 1

September 14, 2009

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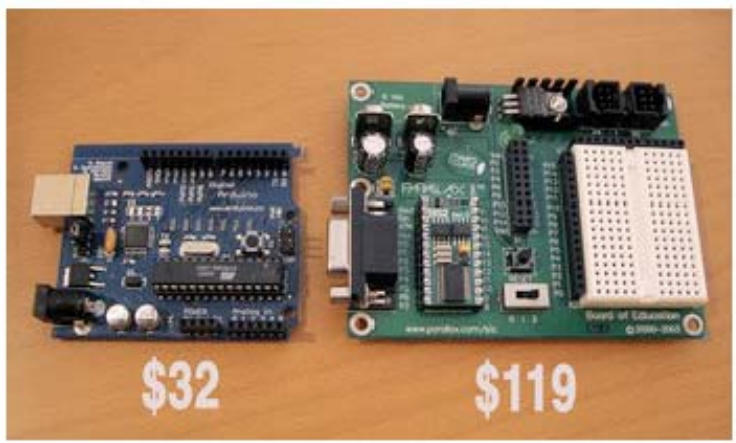
Formal Labs

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

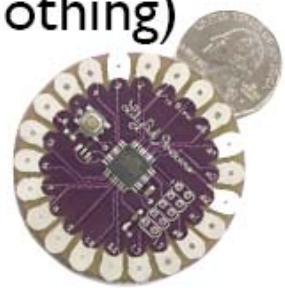


Courtesy of Tod E. Kurt. Used with permission.

http://todbot.com/

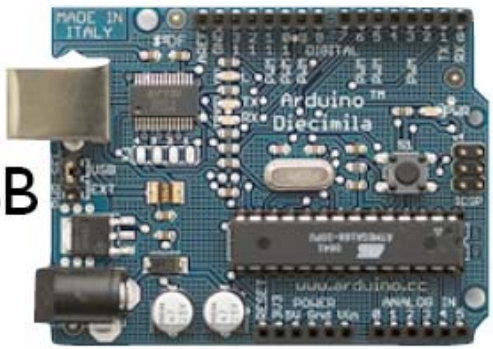
Arduino Hardware

LilyPad
(for clothing)



Photos by SparkFun Electronics.

USB



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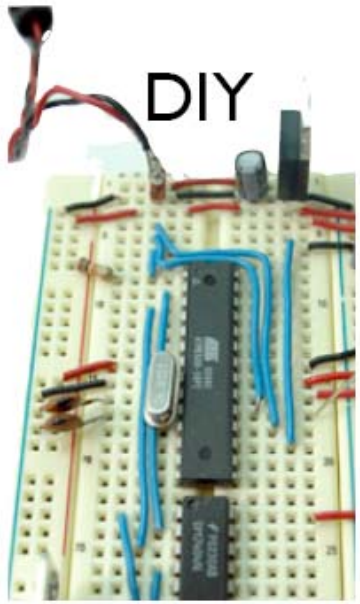
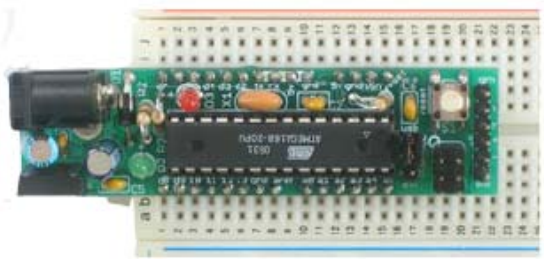
DIY



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/

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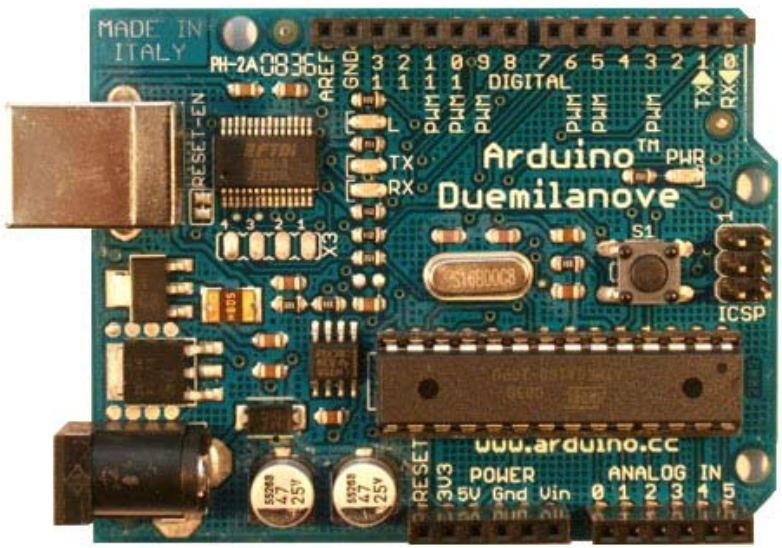
Arduino Duemilanove Microcontroller

http://www.arduino.cc/

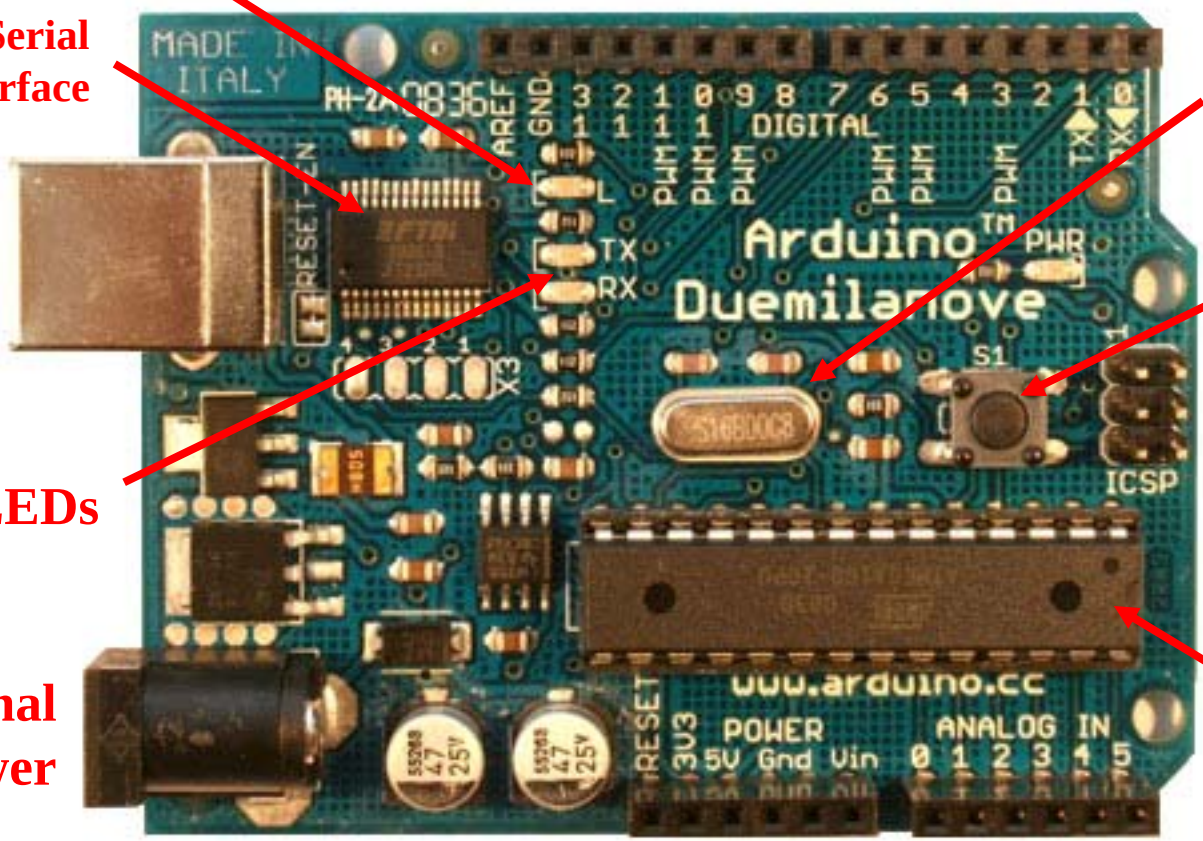


Courtesy of Arduino.cc. Used with permission.

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



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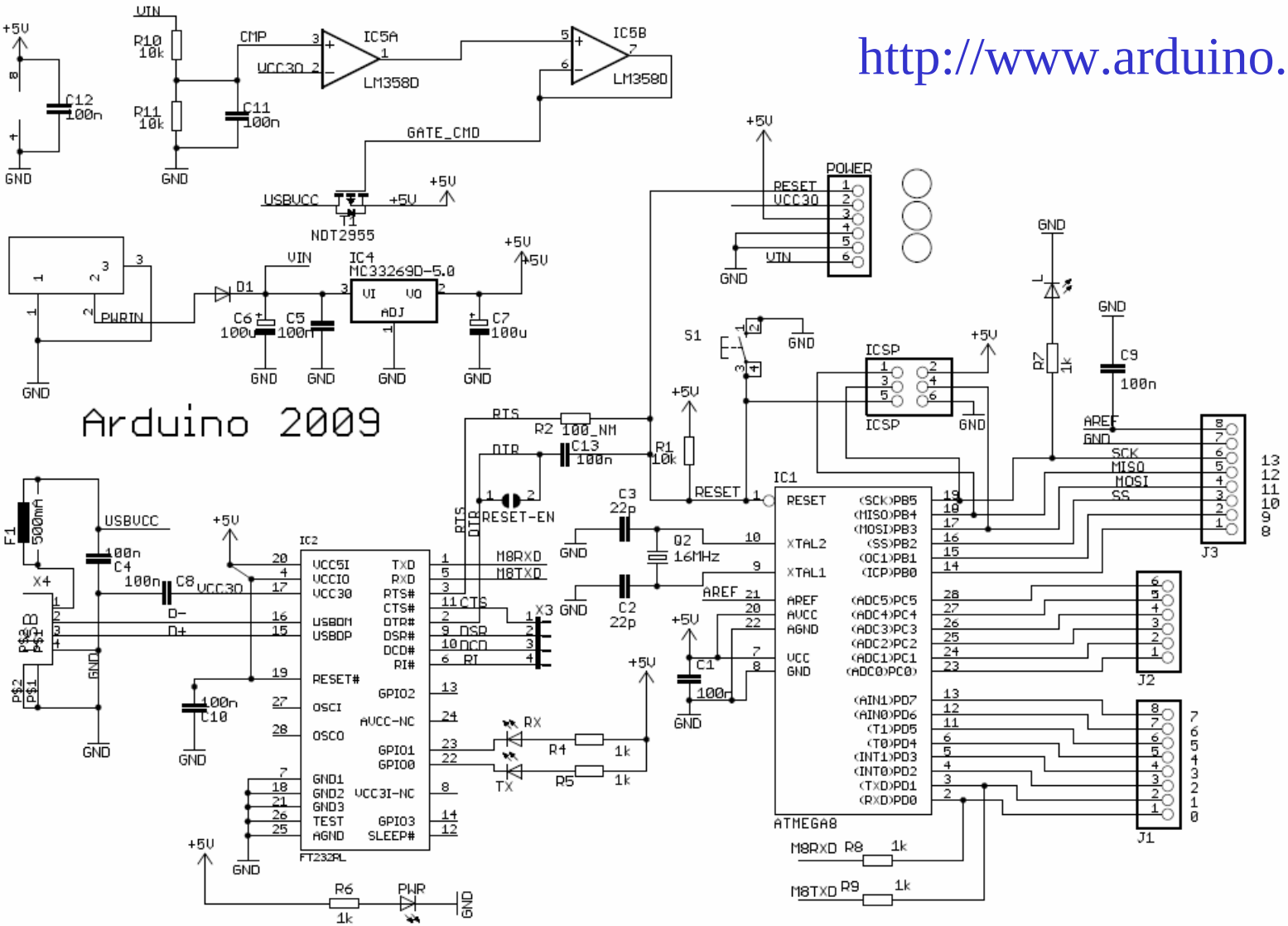
Arduino Circuit Diagram

http://www.arduino.cc/



Courtesy of Arduino.cc. Used with permission.

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 Arduio Kit Experiments

MITMECHE

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

Lab 1

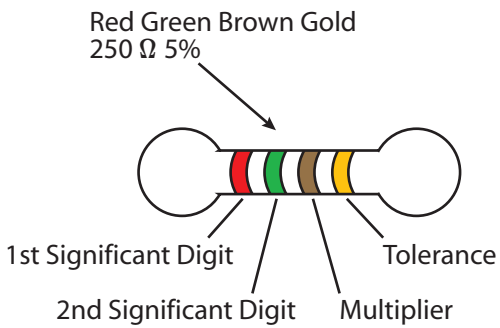
- {CIRC03} Spin Motor Spin - (Transistor and Motor)
- {CIRC04} A Single Servo - (Servos)
- {CIRC05} 8 More LEDs - (74HC595 Shift Register)
- {CIRC06} Music - (Piezo Elements)
- {CIRC07} Button Pressing - (Pushbuttons)
- {CIRC08} Twisting - (Potentiometers)

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
2 5 0 Ω 5%

Figure by MIT OpenCourseWare.

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