Basic Electronic Toolkit

for under $40

- Multimeter http://www.mpja.com/prodinfo.asp?number=17191+TE
- Small Wire cutters http://www.mpja.com/prodinfo.asp?number=16761+TL
- Wire strippers http://www.mpja.com/prodinfo.asp?number=11715+TL
- Needle nose pliers http://www.mpja.com/prodinfo.asp?number=15395+TL
- Xacto knife
- Soldering iron and sponge http://www.mpja.com/prodinfo.asp?number=15860+TL
- Solder
- Solder sucker or desoldering braid http://www.mpja.com/prodinfo.asp?number=0041+TL
- Solderless Breadboard http://www.mpja.com/prodinfo.asp?number=18103+TE
- Assorted screw drivers

Also useful:

- Small vise http://www.mpja.com/prodinfo.asp?number=17500+TL
- Hot melt glue gun
- miscellaneous pliers

Sensor Safari Discussion

Doorbell
(sensor)

Solenoid Valve
(transducer)

Binary Sensors

i.e. switches

- push button
- toggle
- key switch
- mercury tilt
- PIR motion
- magnetic
- thermal
- humidity
- air pressure…

<u>Context is important</u>

Resistive Sensors

sense a range of values

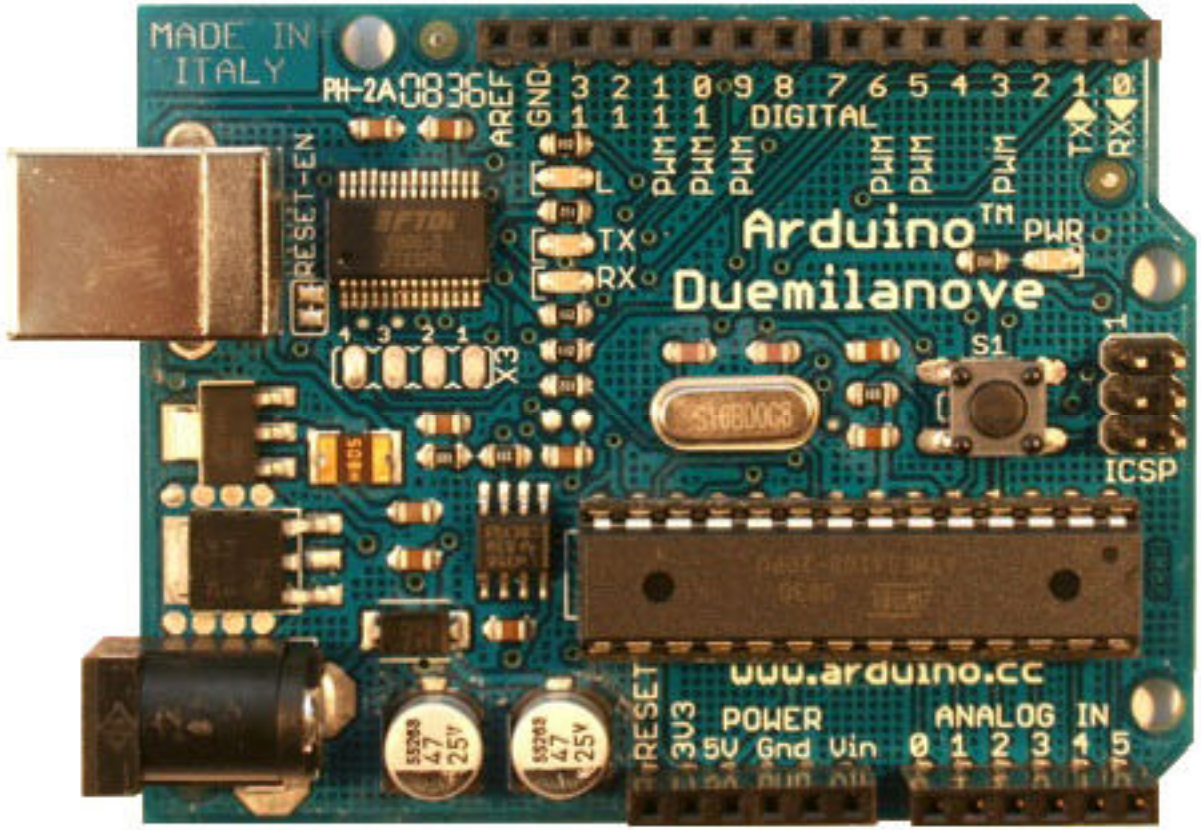
- Light level - photocell
- Position - flex sensors
- Tactile Pressure – conductive foam
- Temperature - thermistor

Advanced Sensors

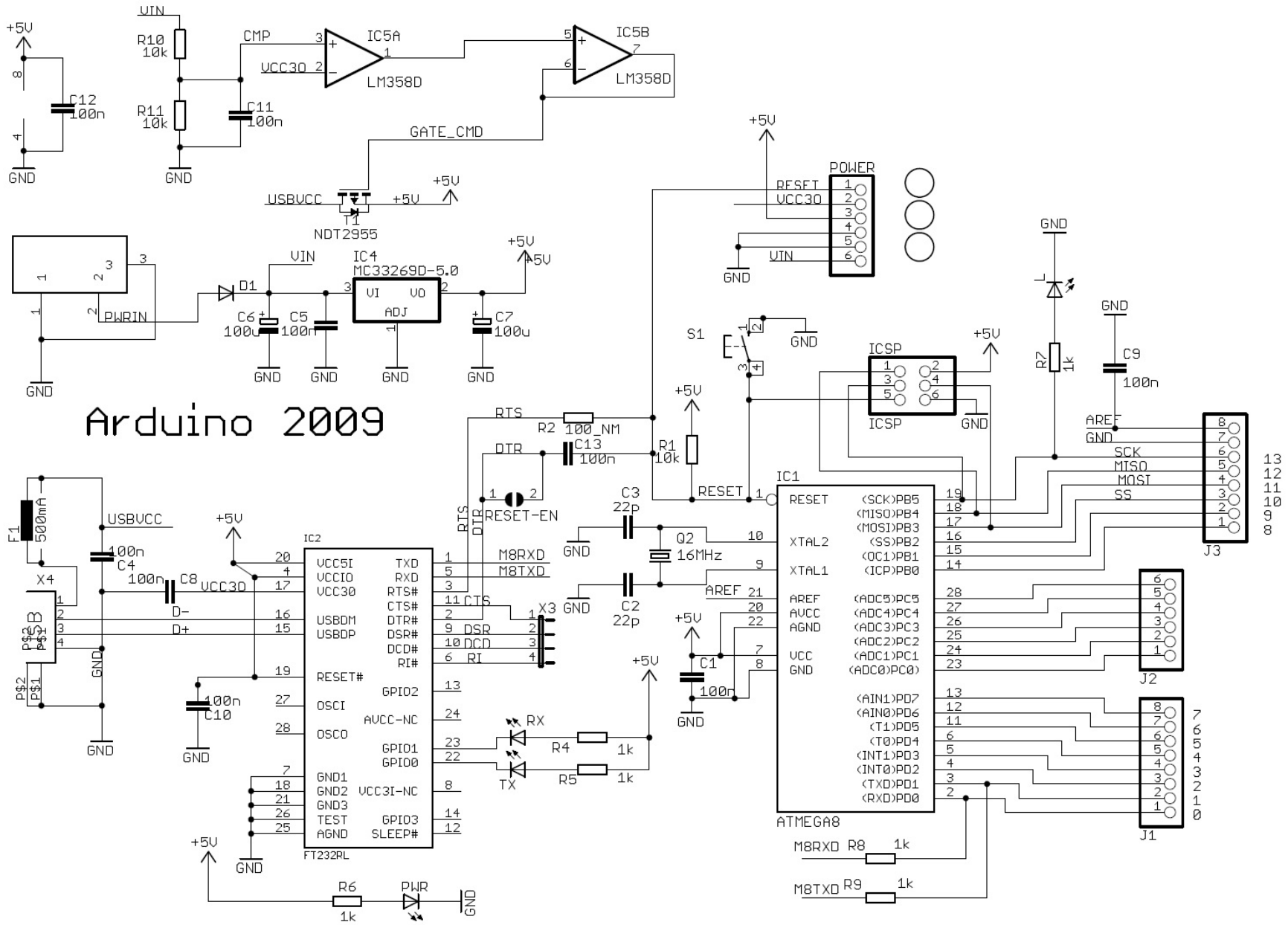
- accelerometers
- distance - ultrasonic, IR
- capacitive proximity
- microphones
- GPS …

Arduino – a small, stand-alone computer

Digital Inputs or Outputs

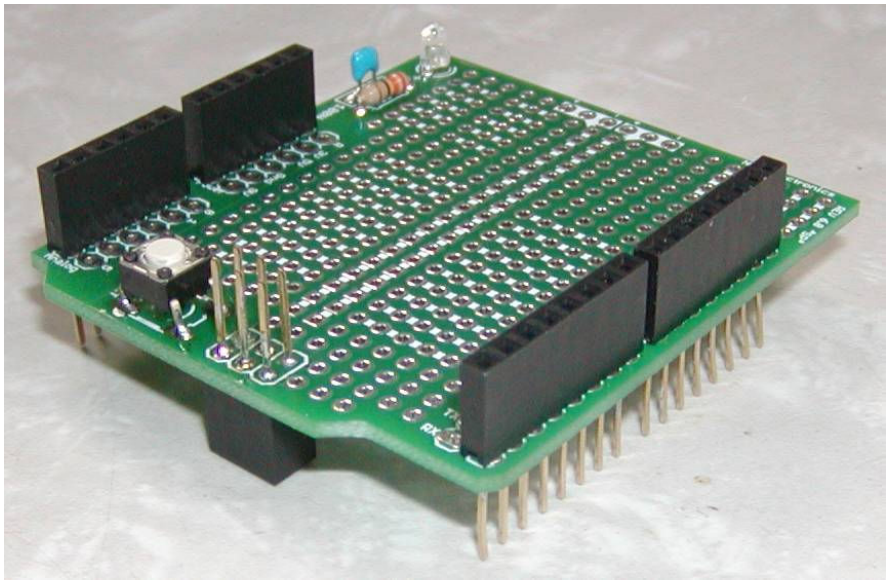


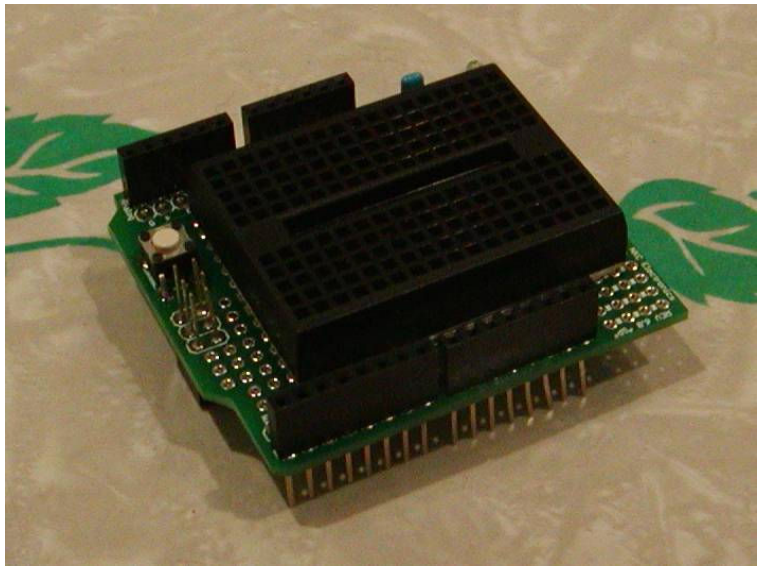
Power *Analog Inputs*


Arduino 2009
+5V
VIN
R10 10k
R11 10k
CMP
VCC30
IC5A
LM358D
IC5B
LM358D
C12 100n
C11 100n
GATE_CMD
USBVCC
T1
NDT2955
PWRIN
D1
IC4
MC33269D-5.0
VI
VO
ADJ
C6 100u
C5 100n
C7 100u
POWER
RESET
VCC30
VIN
S1
ICSP
R7 1k
C9 100n
AREF
SCK
MISO
MOSI
SS
J3
J2
J1
RTS
DTR
R2 100_NM
C13 100n
R1 10k
RESET-EN
C3 22p
C2 22p
Q2 16MHz
IC1
RESET
XTAL2
XTAL1
AREF
AVCC
AGND
VCC
GND
(SCK)PB5
(MISO)PB4
(MOSI)PB3
(SS)PB2
(OC1)PB1
(ICP)PB0
(ADC5)PC5
(ADC4)PC4
(ADC3)PC3
(ADC2)PC2
(ADC1)PC1
(ADC0)PC0
(AIN1)PD7
(AIN0)PD6
(T1)PD5
(T0)PD4
(INT1)PD3
(INT0)PD2
(TXD)PD1
(RXD)PD0
ATMEGA8
C1 100n
F1 500mA
X4
USB
C4 100n
C8 100n
C10 100n
D-
D+
IC2
VCC5I
VCCIO
VCC30
USBDM
USBDP
RESET#
OSCI
OSCO
GND1
GND2
GND3
TEST
AGND
TXD
RXD
RTS#
CTS#
DTR#
DSR#
DCD#
RI#
GPIO2
AVCC-NC
GPIO1
GPIO0
VCC3I-NC
GPIO3
SLEEP#
FT232RL
M8RXD
M8TXD
X3
CTS
DSR
DCD
RI
RX
TX
R4 1k
R5 1k
R6 1k
PWR
R8 1k
R9 1k

ProtoShield

plugs into top of Arduino board

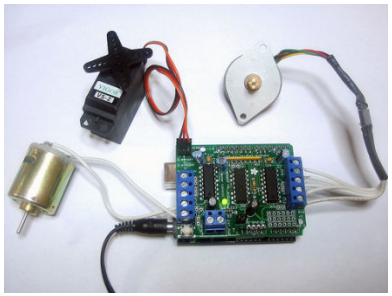


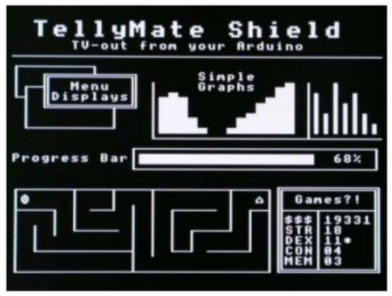


Assembly instructions for the other (Ladyada) version may be found at:
http://www.ladyada.net/make/pshield/make.html

Arduino Shields

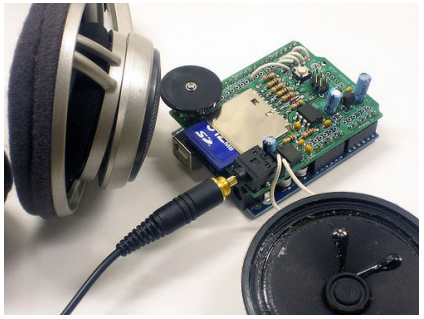
Extend Arduino Capabilities

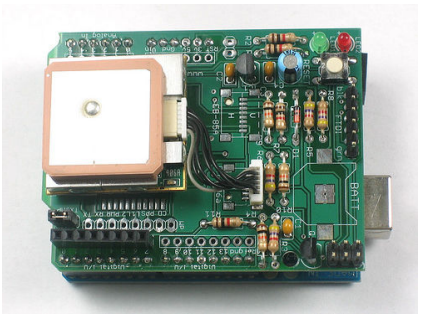




Example Shields:

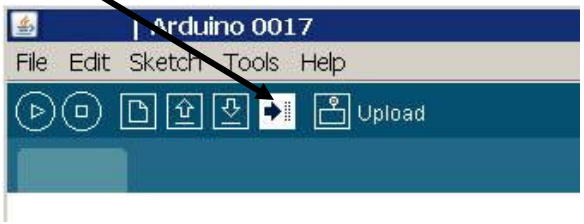
- Xbee (wireless communications)
- Wave (audio playback, MP3)
- GPS & data logging
- Lithium Backpack (battery power)
- Motor Shield
- Button Shield
- Video (Atari quality)





Arduino Programming Steps

- Open an existing program or write a new one
- “VERIFY” checks “Sketch” (program) for mistakes
- “UPLOAD” copies program to Arduino board



- Program can then run without PC
- Program restarts whenever Arduino power is applied or reset button is pressed
- Arduino can be powered by USB or external 7-12V supply

Arduino Programming Elements

- Comments: // or /* write stuff here */

- Variables
  - declared at beginning
  - used to store numeric values or text
- Functions
  - Setup (only executed once)
  - Loop (main part of program, continuously repeated)

- Digital I/O Pins are general purpose, configure them in Setup
  - pinMode(PinNumber, OUTPUT);

- Analog capable outputs (pins 9,10,11) should be set as outputs if needed

- Analog input pins (0-5) do not need to be configured

Arduino Programming Notes

- Every line has to end with a semicolon ;
- Curly Braces { } frame blocks of code
- Spelling and capitalization counts!

  “digitalread(x)” is not the same as “digitalRead(x)”
- Program text is color coded to help you spot mistakes
- Appendix C in *Getting Started with Arduino* summarizes commands and the Arduino program structure.

Program Exercises

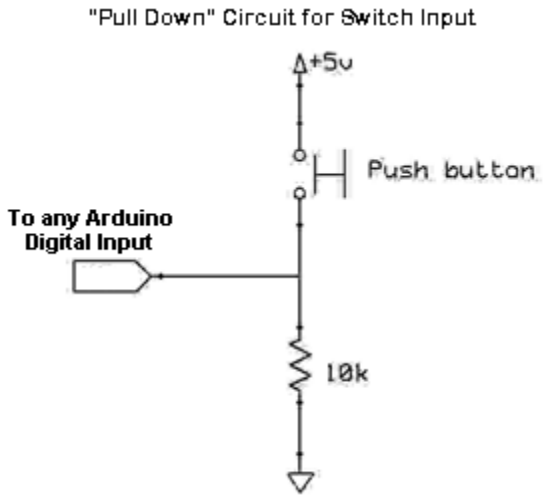
- From Arduino Examples
  - Blink LED (binary output)
  - Fade LED (analog output)
- Add switch to change fade rate (
  - binary input
  - if { } else { }
- Attach a photosensor (analog input)
- Adjust blink rate based on light level
- Send light level values to Mac using Serial.print

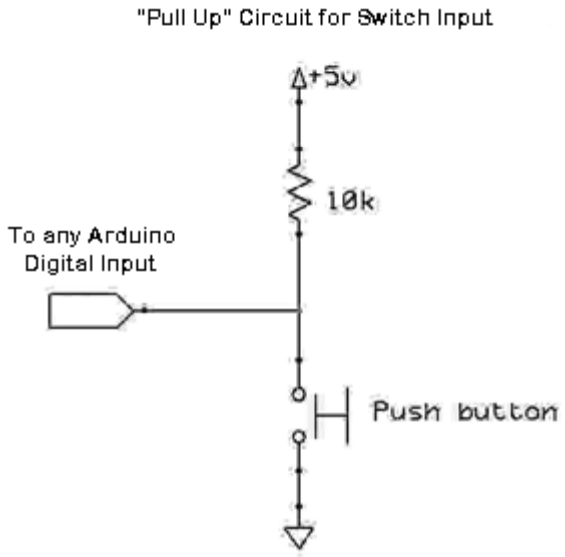
- FYI, example programs from the book can be found here:

  http://makezine.com/getstartedarduino/

  Copy and and paste them into an Arduino window, modify if desired, and then upload them to the board.

Circuits for Binary Input





Circuit for Binary Input

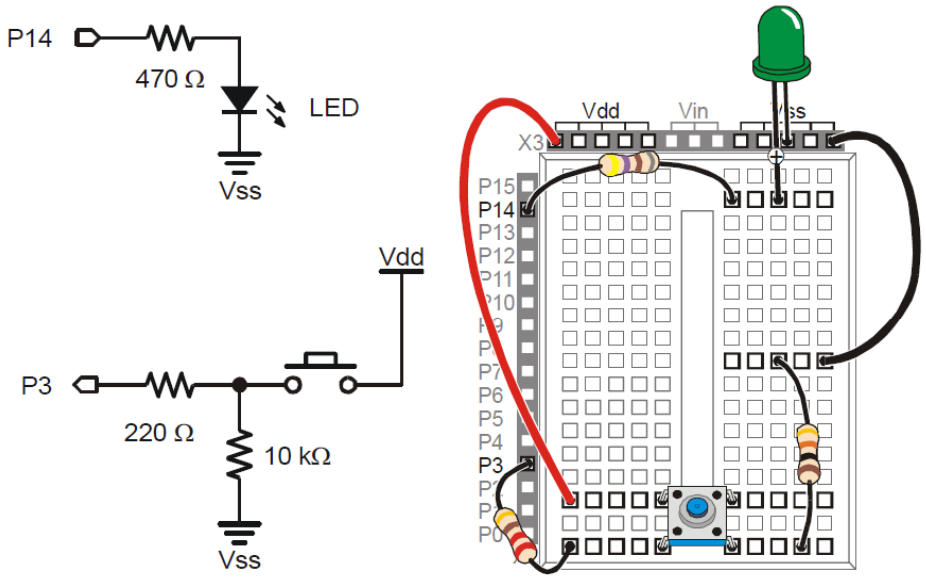
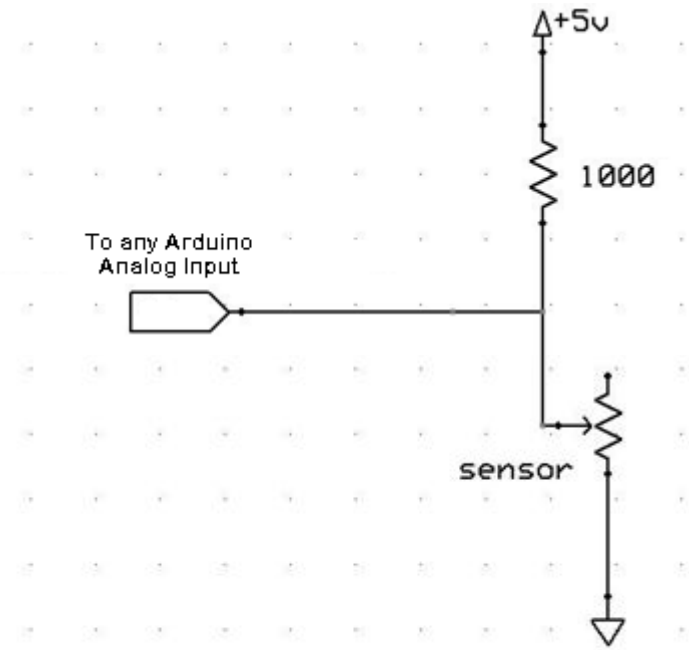


Figure 3-11
Pushbutton and
LED Circuit

NOTE:
V_{dd} = 5V
V_{ss} = GND

What's a Microcontroller page 81

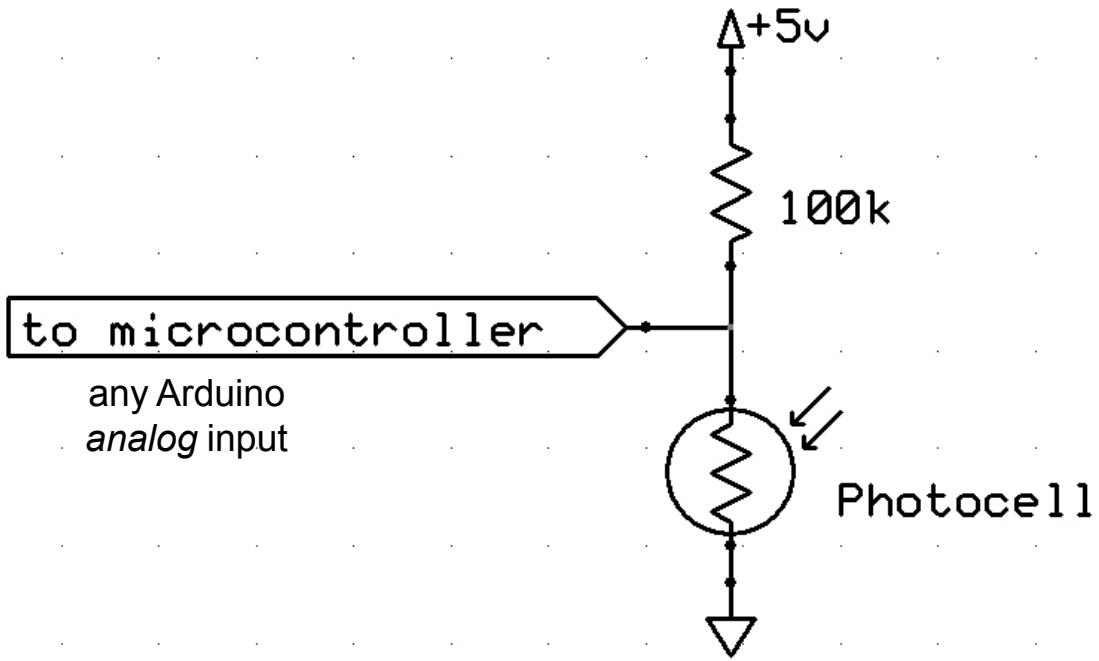
Circuit for Resistive Sensor



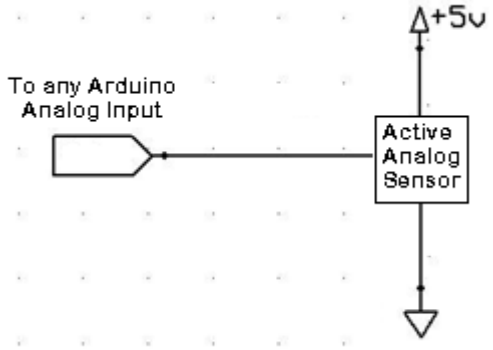
Circuit for Resistive Sensor Input

Choose a resistor equal to about 1/3 of the sensor's value

Connecting a Photocell as a Sensor



Circuit for Analog Input from an “Active Sensor”



Active Sensor

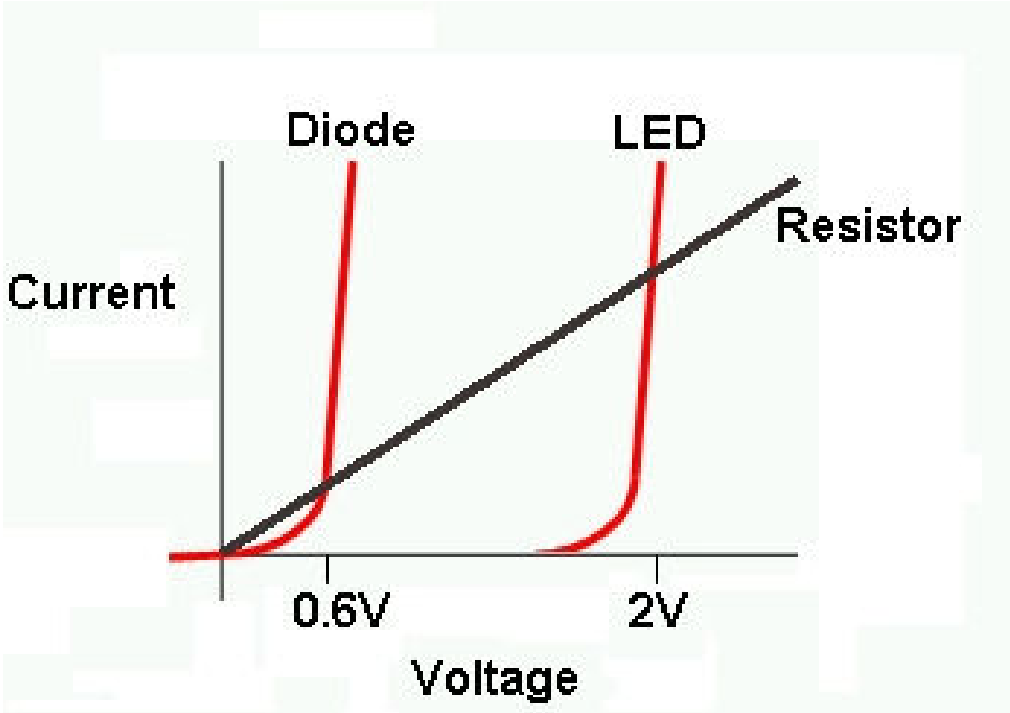
- Requires Power
- Generates an analog signal
- Generally 0-5V output
- Example: distance sensors

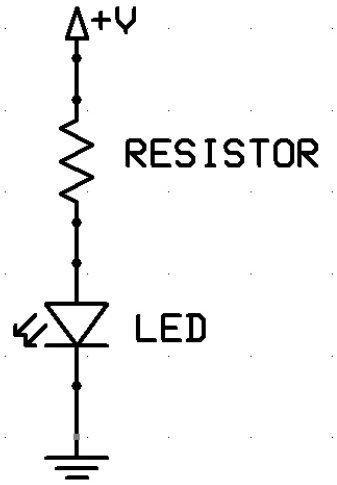
Sensors & Transducers <> Inputs & Outputs

- Binary Input (Switch)
- Binary Output (on or off)
- Analog Input (resistive sensors)
- Analog Output (PWM)

More on Diodes

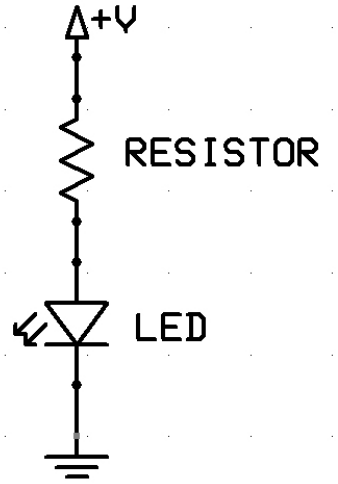
- Resistors Follow Ohms law: V = IR
- Diodes DO NOT follow Ohms Law
- Diodes have a voltage drop across them (like a resistor)
- But diode voltage is (relatively) independent of current thru the diode





Choosing a Resistor for an LED

- LEDs have a characteristic voltage drop
- This Voltage is independent of current thru the LED
- Voltage varies based on LED type
- Voltage is in the range of 1.5 to 4V
- Desired current thru an LED is about 20mA
- Use Ohms law to find a resistance that will give you 20mA of current



Ohms Law: V=IR

$V_{supply} - V_{LED} = (20mA)\ R$

Example:

$$\frac{5V - 2V}{20mA} = 100\Omega$$

Programming

- Conditional: If { } else { }
- Loop: For { }
- Input and Output
  - pinMode(pin#, input or output)
  - digitalWrite(pin#, HIGH or LOW)
  - digitalRead(pin#)
  - analogWrite(pin#, 0-255)
  - analogRead(pin#)
- Serial Communications
  - Serial.begin(baud rate)
  - Serial.println(number)

Assignments

- Build LED flasher kit
- Build protoshield
  - See earlier slide for example image of NKC electronics version
  - Assembly instructions for the Ladyada version may be found at:
    http://www.ladyada.net/make/pshield/make.html
- Read Chapter 5 and Appendix C in *Getting Started with Arduino*
- Extra Credit:

  In class we worked with two Arduino programs, one (Blink) flashed an LED on and off every second, the other (Fading) made the brightness of an LED fade slowly in and out. Connect 2 LEDs to the Arduino and write a program (or modify the Blink or Fading program) to make one LED fade in and out and the other flash on and off.