Arduino Start Kit

User Manual

Tinyos Electronics @ 2011

Version 2.0

About This KIT

The overall goal of this kit is fun. Beyond this, the aim is to get you comfortable using a wide range of electronic components through small, simple and easy circuits. The focus is to get each circuit working then giving you the tools to figure out why. If you encounter any problems, want to ask a question, or would like to know more about any part, please contact with us :Tim@tinyosshop.com.

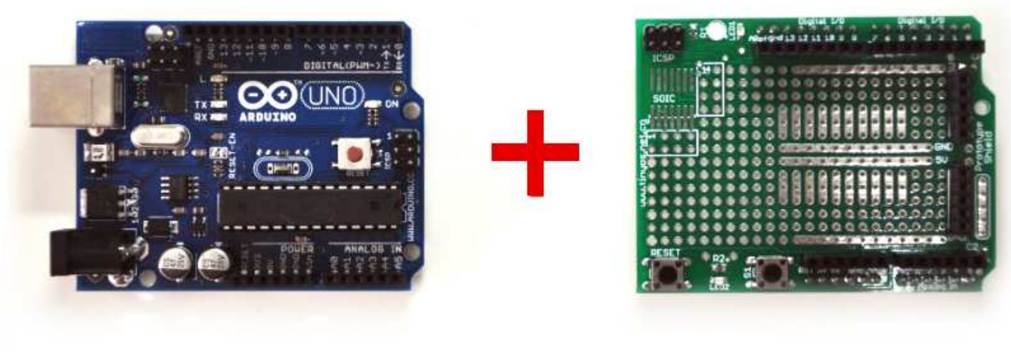
Kit Details:

- Tosduino duemilanove x1
- Prototype Shield x1
- Breadboard-mini x1
- 10K ohm Resistor x10
- 1K ohm Resistor x10
- 220 ohm Resistor x10
- Jumper wire x 20
- LED-Red/Green/Yellow x2
- Buzzer x1
- Pushbutton x4
- Segment LED x1
- Protoresistor x1
- Infrared Receiver x1
- LM35 Temperature Sensor x1
- Mini Infrared Remote Control x1
- Battery Box x1
- USB Cable x1

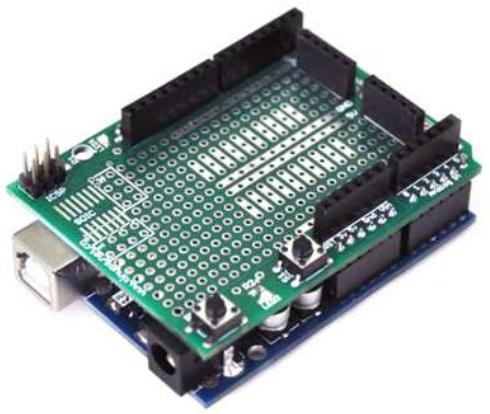
Before We Start

PUTTING IT TOGETHER

STEP1

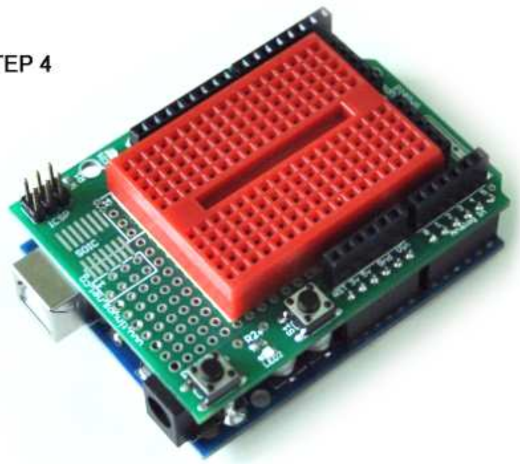


STEP2



STEP 3

STEP 4



INSTALLING THE IDE

This is the program used to write code for the Arduino. It may seem a little daunting at first but once you have it installed and start playing around, its secrets will reveal themselves.

Step 1: Download the software

Go to
http://arduino.cc/en/Main/Software download the software for your operating system.

And then there are two ways of Windows and Mac OSX

Windows XP

Step 2: Unzip the Software

Unzip arduino-00xx-win.zip **Recommended Path** c:\Program Files\

Step 3: Shortcut Icon

Open c:\program files\arduino-00 **Right Click** Arduino.exe (send to>Desktop (create shortcut))

Step 4: Plug In Your Arduino

Plug your Arduino in: Using the included USB cable, plug your Arduino board into a free USB port.**Wait for a box to pop up**

Step 5: Add new Hardware

Skip searching the internet
(click the next box when prompted to do so)
Install from a specific location
(click "Install from a list or specific location (Advanced)")
Choose the Location
Duemilanove Board:
c:\program files\arduino-00xx\ drivers\FTDI USB Drivers\
Uno Board
c:\program files\arduino-00xx\drivers\
Finished

Vista, Seven

Step 5: Add new Hardware

Run Device Manager

Start > Run > devmgmt.msc

Choose the Arduino

Other Devices > Arduino Uno (Uno)

Update Driver

click "Update Driver"

Select Driver

click "Browse My Computer for Driver Software"

c:\program files\arduino-00xx\drivers\

Finished

Mac OSX

Step 2: Open The .dmg

Open (mount) arduino-00xx-mac.dmg (×× - version).

Step 3: Copy The Application

Go to

"Arduino" (in the devices section of finder)

Move

"Arduino" Application to the

"Applications" folder

Step 4: Install Drivers

Duemilanove Boards Only:.

Go to

"Arduino" device

FTDI Drivers for Intel Macs (x_x_xx).pkg

FTDI Drivers for PPC Macs (x_x_xx).pkg

Restart

Step 5: Plug In Your Arduino

Plug your Arduino in:

Using the included USB cable, plug your Arduino board into a free USB port.

Finished

A Small Programming Primer

ARDUINO PROGRAMMING IN BRIEF

The Arduino is programmed in the C language. This is a quick little primer targeted at people who have a little bit of programing experience and just need a briefing on the idiosyncracies of C and the Arduino IDE. If you find the concepts a bit daunting, don't worry, you can start going through the circuits and pick up most of it along the way. For a more in-depth intro, the Arduino.cc website is a great resource.

STRUCTURE

Each Arduino program (often called a sketch) has two required functions (also called routines).

void setup(){ } All the code between the two curly brackets will be run once when your Arduino program first runs.
void loop(){ } This function is run after setup has finished. After it has run once it will be run again, and again, until power is removed.

SYNTAX

One of the slightly frustrating elements of C is its formatting requirements (this also makes it very powerful). If you remember the following you should be alright.

// (single line comment) It is often useful to write notes to yourself as you go along about what each line of code does. To do this type two forward slashes and everything until the end of the line will be ignored by your program.
/* */ (multi line comment) If you have a lot to say you can span several lines as a comment. Everything between these two symbols will be ignored in your program.
{ } (curly brackets) Used to define when a block of code starts and ends (used in functions as well as loops).
; (semicolon) Each line of code must be ended with a semicolon (a missing semicolon is often the reason for a program refusing to compile).

VARIABLES

A program is nothing more than instructions to move numbers around in an intelligent way. Variables are used to do the moving.

int (integer) The main workhorse, stores a number in 2 bytes (16 bits). Has no decimal places and will store a value between -32,768 and 32,767.
long (long) Used when an integer is not large enough. Takes 4 bytes (32 bits) of RAM and has a range between -2,147,483,648 and 2,147,483,647.
boolean (boolean) A simple True or False variable. Useful because it only uses one bit of RAM.
float (float) Used for floating point math (decimals). Takes 4 bytes (32 bits) of RAM and has a range between -3.4028235E+38 and 3.4028235E+38.
char (character) Stores one character using the ASCII code (ie 'A' = 65). Uses one byte (8 bits) of RAM. The Arduino handles strings as an array of char's.

MATH OPERATORS

Operators used for manipulating numbers. (they work like simple math).

= (assignment) makes something equal to something else (eg. x= 10 * 2 (x now equals 20))
% (modulo) gives the remainder when one number is divided by another (ex. 12 % 10 (gives 2))
+ (addition)
- (subtraction)
***** (multiplication)
/ (division)

COMPARISON OPERATORS

Operators used for logical comparison.

== (equal to) (eg. 12 == 10 is FALSE or 12 == 12 is TRUE)
!= (not equal to) (eg. 12 != 10 is TRUE or 12 != 12 is FALSE)
< (less than) (eg. 12 < 10 is FALSE or 12 < 12 is FALSE or 12 < 14 is TRUE)
> (greater than) (eg. 12 > 10 is TRUE or 12 > 12 is FALSE or 12 > 14 is FALSE)

CONTROL STRUCTURE

Programs are reliant on controlling what runs next, here are the basic control elements (there are many more online).

if(condition){ }
else if(condition){ }
else { }
This will execute the code between the curly brackets if the condition is true, and if not it will test the else if condition if that is also false the else code will execute.

for(int i = 0; i <#repeats; i++){ } Used when you would like to repeat a chunk of code a number of times (can count up i++ or down i-- or use any variable)

DIGITAL

pinMode(pin, mode); Used to set a pin's mode, pin is the pin number you would like to address 0-19 (analog 0-5 are 14-19). The mode can either be INPUT or OUTPUT.
digitalWrite(pin, value); Once a pin is set as an OUTPUT,it can be set either HIGH (pulled to +5 volts) or LOW (pulled to ground).
int digitalRead(pin); Once a pin is set as an INPUT you can use this to return whether it is HIGH (pulled to +5 volts) or LOW (pulled to ground).

ANALOG

The Arduino is a digital machine but it has the ability to operate in the analog realm (through tricks). Here's how to deal with things that aren't digital.

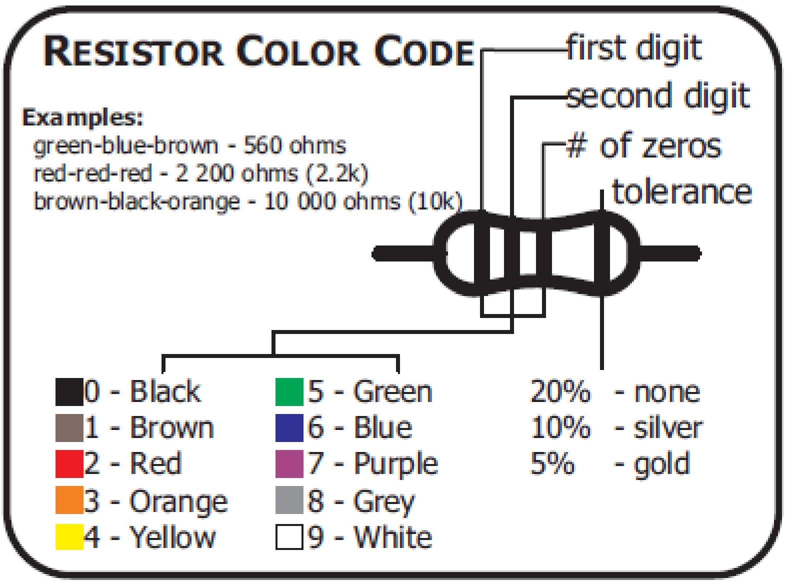
int analogWrite(pin, value); Some of the Arduino's pins support pulse width modulation (3, 5, 6, 9, 10, 11). This turns the pin on and off very quickly making it act like an analog output. The value is any number between 0 (0% duty cycle ~0v) and 255 (100% duty cycle ~5 volts).
int analogRead(pin); When the analog input pins are set to input you can read their voltage. A value between 0 (for 0 volts) and 1024 (for 5 volts) will be returned.

A Small Electronics Primer

COMPONENT DETAILS

LED **(Light Emitting Diode)** 	**What it Does:** Emits light when a small current is passed through it. (only in one direction) **Identifying:** Looks like a mini light bulb.	**No. of Leads:** 2 (one longer, this one connects to positive) **Things to watch out for:** - Will only work in one direction - Requires a current limiting resistor
Diode 	**What it Does:** The electronic equivalent of a one way valve. Allowing current to flow in one direction but not the other. **Identifying:** Usually a cylinder with wires extending from either end. (and an off center line indicating polarity)	**No. of Leads:** 2 **Things to watch out for:** - Will only work in one direction (current will flow if end with the line is connected to ground)
Resistors 	**What it Does:** Restricts the amount of current that can 2 flow through a circuit. **Identifying:** Cylinder with wires extending from either end. The value is displayed using a color coding system (for details see next page)	**No. of Leads:** 2 **Things to watch out for:** - Easy to grab the wrong value
Transistor 	**What it Does:** Uses a small current to switch or amplify a much larger current. **Identifying:** Comes in many different packages but you can read the part number off the package. (8050 in this kit and find a datasheet online)	**No. of Leads:** 3 (Base, Collector, Emitter) **Things to watch out for:** - Plugging in the right way round (also a current limiting resistor is often needed on the base pin)
Hobby Servo 	**What it Does:** Takes a timed pulse and converts it into an angular position of the output shaft. **Identifying:** A plastic box with 3 wires coming out one side and a shaft with a plastic horn out the top.	**No. of Leads:** **3** **Things to watch out for:** - The plug is not polarized so make sure it is plugged in the right way.
DC Motor	**What it Does:** Spins when a current is passed through it. **Identifying:**	**No. of Leads:** 2 **Things to watch out for:**

	This one is easy, it looks like a motor. Usually a cylinder with a shaft coming out of one end.	- Using a transistor or relay that is rated for the size of motor you're using.
Buzzer	**What it Does:** A pulse of current will cause it to click. A stream of pulses will cause it to emit a tone. **Identifying:** In this kit it comes in a little black barrel, but sometimes they are just a gold disc.	**No. of Leads:** **2** **Things to watch out for:** - Difficult to misuse.
Pushbutton	**What it Does:** Completes a circuit when it is pressed. **Identifying:** A little square with leads out the bottom and a button on the top.	**No. of Leads:** **4** **Things to watch out for:** - these are almost square so can be inserted 90 degrees off angle.
Photo Resistor	**What it Does:** Produces a variable resistance dependant on the amount of incident light. **Identifying:** Usually a little disk with a clear top and a curvy line underneath.	**No. of Leads:** **2** **Things to watch out for:** - Remember it needs to be in a voltage divider before it provides a useful input.



Getting Started:

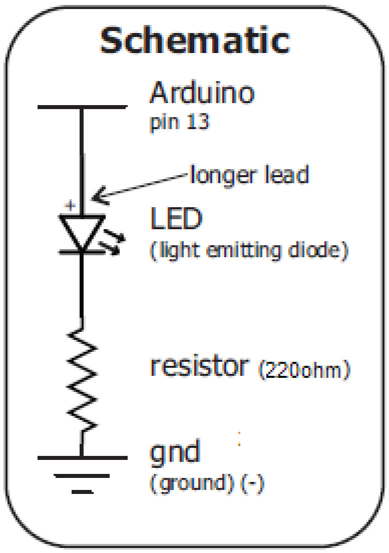
Lesson 1: Blinking LED

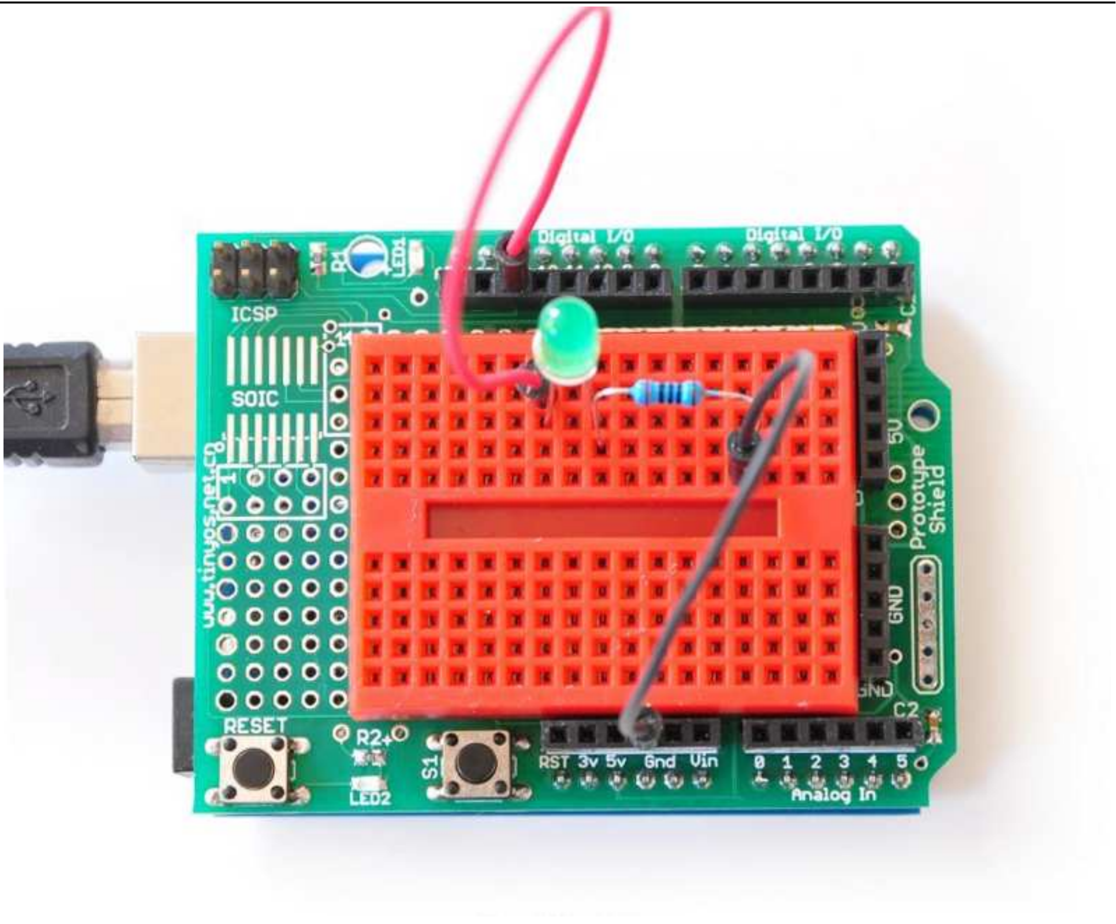
LEDs (light emitting diodes) are used in all sorts of clever things which is why we have included them in this kit. We will start off with something very simple, turning one on and off, repeatedly, producing a pleasant blinking effect. To get started, grab the parts listed below, pin the layout sheet to your breadboard and then plug everything in. Once the circuit is assembled you'll need to upload the program. To do this plug the Arduino board into your USB port. Then select the proper port in **Tools > Serial Port > (the comm port of your Arduino).** Next upload the program by going to **File > Upload to I/O Board (ctrl+U).** Finally, bask in the glory and possibility that controlling lights offers.

THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1
- 5mm Green LED x1
- Jumper Wire x2
- 220 Ohm Resistor x1





CODE

```
/* Blink*/

int ledPin = 13; // LED connected to digital pin 13

// The setup() method runs once, when the sketch starts

void setup() { // initialize the digital pin as an output:

pinMode(ledPin, OUTPUT); }

// the loop() method runs over and over again,

// as long as the Arduino has power

void loop() {

digitalWrite(ledPin, HIGH); // set the LED on

delay(1000); // wait for a second

digitalWrite(ledPin, LOW); // set the LED off

delay(1000); // wait for a second

}
```

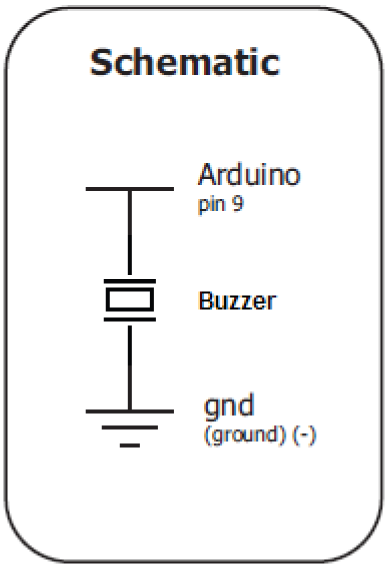
Lesson 2: Buzzer music

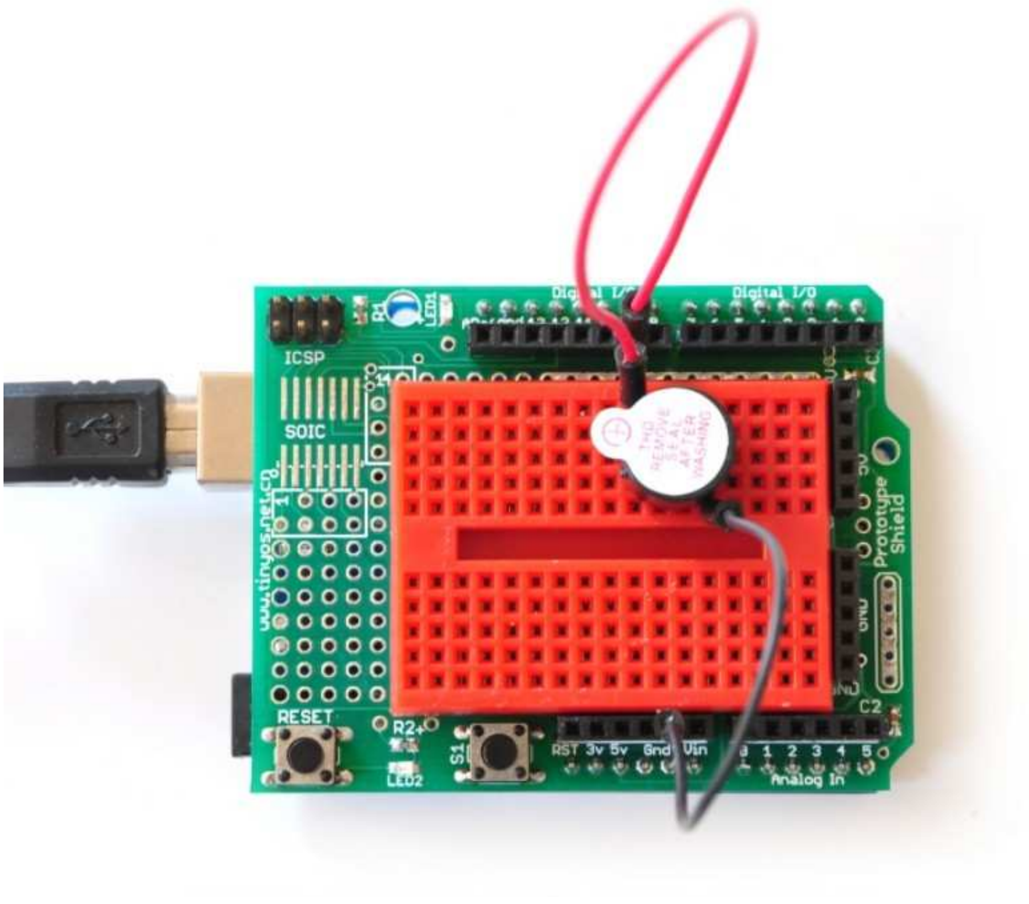
Let's tackle sound next. But sound is an analog phenomena, how will our digital Arduino cope? We will once again rely on its incredible speed which will let it mimic analog behavior. To do this, we will attach a buzzer to one of the Arduino's digital pins. A buzzer makes a clicking sound each time it is pulsed with current. If we pulse it at the right frequency (for example 440 times a second to make the note middle A) these clicks will run together to produce notes. Let's get to experimenting with it and get your Arduino playing "Twinkle Twinkle Little Star".

THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1
- Buzzer x1
- Jumper Wire x2





CODE

```
/* Melody
 * (cleft) 2005 D. Cuartielles for K3
 *
 * This example uses a piezo speaker to play melodies.   It sends
 * a square wave of the appropriate frequency to the piezo, generating
 * the corresponding tone.
 *
 * The calculation of the tones is made following the mathematical
 * operation:
 *
 *         timeHigh = period / 2 = 1 / (2 * toneFrequency)
 *
 * where the different tones are described as in the table:
 *
 * note    frequency          period    timeHigh
 * c                261 Hz            3830       1915
 * d                294 Hz            3400       1700
 * e                329 Hz            3038       1519
 * f            349 Hz        2864      1432
 * g            392 Hz        2550      1275
 * a            440 Hz        2272      1136
 * b            493 Hz        2028      1014
 * C            523 Hz        1912      956
 *
 */

int speakerPin = 9;

int length = 15; // the number of notes
char notes[] = "ccggaagffeeddc "; // a space represents a rest
int beats[] = { 1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 2, 4 };
int tempo = 300;

void playTone(int tone, int duration) {
  for (long i = 0; i < duration * 1000L; i += tone * 2) {
    digitalWrite(speakerPin, HIGH);
    delayMicroseconds(tone);
    digitalWrite(speakerPin, LOW);
    delayMicroseconds(tone);
  }
}

void playNote(char note, int duration) {
  char names[] = { 'c', 'd', 'e', 'f', 'g', 'a', 'b', 'C' };
  int tones[] = { 1915, 1700, 1519, 1432, 1275, 1136, 1014, 956 };

  // play the tone corresponding to the note name
  for (int i = 0; i < 8; i++) {
    if (names[i] == note) {
      playTone(tones[i], duration);
    }
  }
}

void setup() {
  pinMode(speakerPin, OUTPUT);
}

void loop() {
  for (int i = 0; i < length; i++) {
    if (notes[i] == ' ') {
      delay(beats[i] * tempo); // rest
    } else {
      playNote(notes[i], beats[i] * tempo);
    }

    // pause between notes
    delay(tempo / 2);
  }
}
```

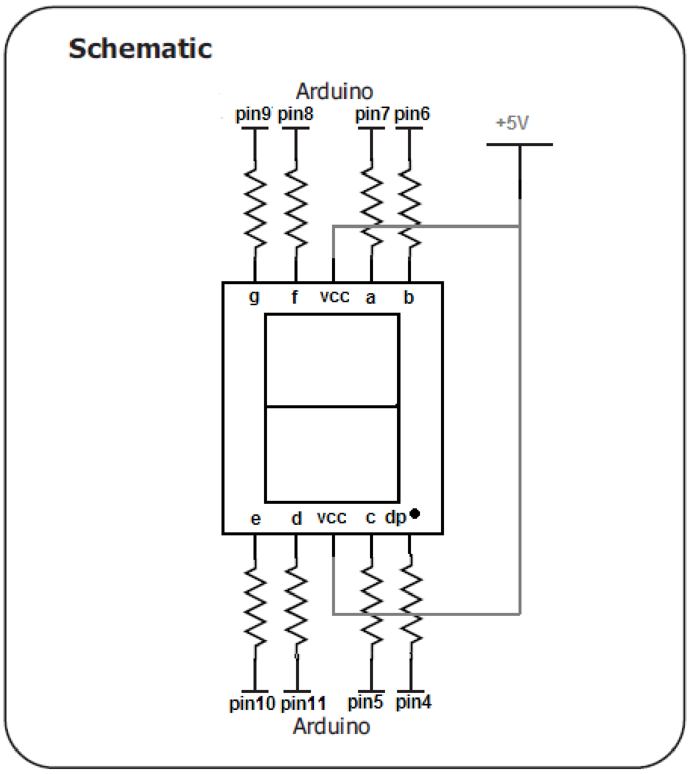
Lesson 3: Segment LED Display

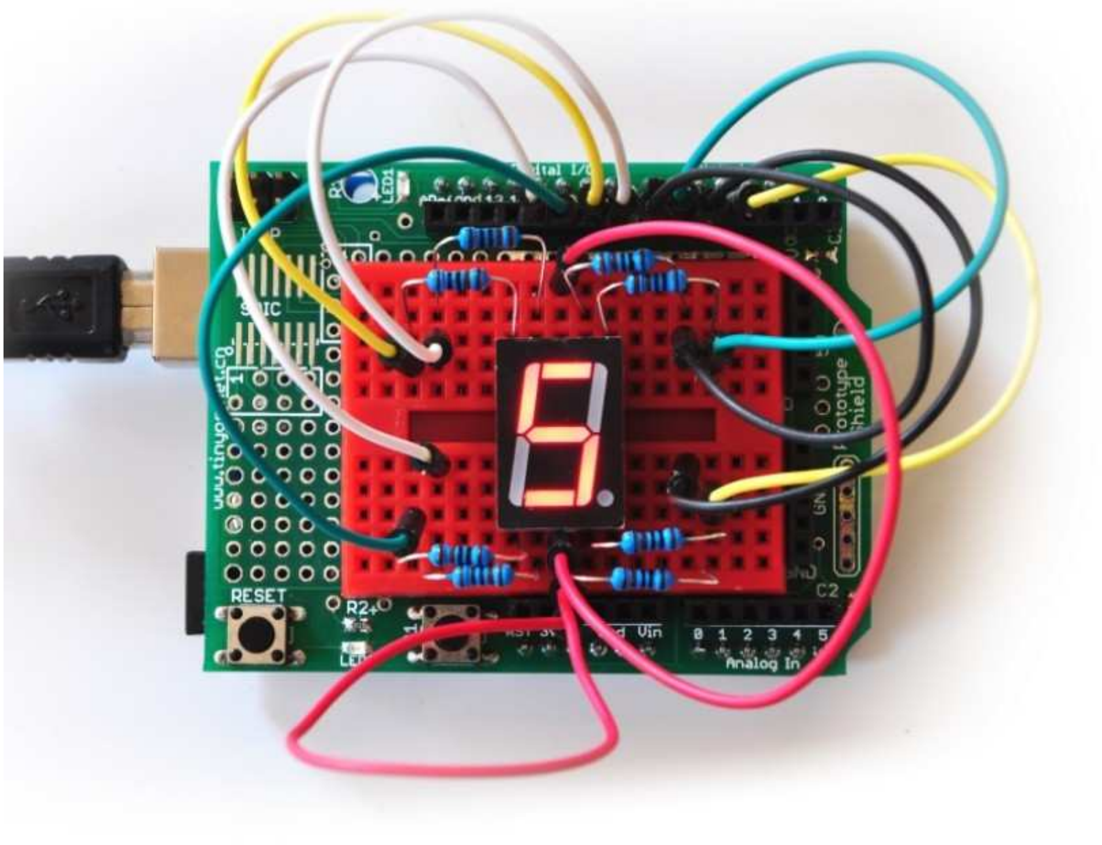
Segement display can be used to display number,this lesson we show how to control it,here we use the basic 7-segment LED.Common anode.

THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1
- 7 Segment LED x1
- Jumper Wire x10
- 1K Ohm Resistor x8





CODE

```
//设置控制各段的数字IO脚
int a=7;
int b=6;
int c=5;
int d=11;
int e=10;
int f=8;
int g=9;
int dp=4;

//display number 1
void digital_1(void)
{
unsigned char j;
digitalWrite(c,LOW);//Set pin5 to low which lights the C segment
digitalWrite(b,LOW);// Set pin6 to low which lights the C segment
for(j=7;j<=11;j++)//turn off the other segment
digitalWrite(j,HIGH);
digitalWrite(dp,HIGH);//turn off dp segment(the little dot on the right down part)
}
//display number 2
void digital_2(void)
{
unsigned char j;
digitalWrite(b,LOW);
digitalWrite(a,LOW);
for(j=9;j<=11;j++)
digitalWrite(j,LOW);
digitalWrite(dp,HIGH);
digitalWrite(c,HIGH);
digitalWrite(f,HIGH);
}
//display number 3
void digital_3(void)
{
unsigned char j;
digitalWrite(g,LOW);
digitalWrite(d,LOW);
for(j=5;j<=7;j++)
digitalWrite(j,LOW);
digitalWrite(dp,HIGH);
digitalWrite(f,HIGH);
digitalWrite(e,HIGH);
}
//display number 4
void digital_4(void)
{
digitalWrite(c,LOW);
digitalWrite(b,LOW);
digitalWrite(f,LOW);
digitalWrite(g,LOW);
digitalWrite(dp,HIGH);
digitalWrite(a,HIGH);
digitalWrite(e,HIGH);
digitalWrite(d,HIGH);
}
//display number 5
void digital_5(void)
{
unsigned char j;
for(j=7;j<=9;j++)
digitalWrite(j,LOW);
digitalWrite(c,LOW);
digitalWrite(d,LOW);
digitalWrite(dp,HIGH);
digitalWrite(b,HIGH);
digitalWrite(e,HIGH);
}
//display number 6
void digital_6(void)
{
unsigned char j;
for(j=7;j<=11;j++)
digitalWrite(j,LOW);
digitalWrite(c,LOW);
digitalWrite(dp,HIGH);
digitalWrite(b,HIGH);
}
//display number 7
void digital_7(void)
{
unsigned char j;
for(j=5;j<=7;j++)
digitalWrite(j,LOW);
digitalWrite(dp,HIGH);
for(j=8;j<=11;j++)
digitalWrite(j,HIGH);
}
//display number 8
void digital_8(void)
{
unsigned char j;
for(j=5;j<=11;j++)
digitalWrite(j,LOW);
digitalWrite(dp,HIGH);
}
void setup()
{
int i;
for(i=4;i<=11;i++)
pinMode(i,OUTPUT);//set Pin mode as output
}
void loop()
{
while(1)
{
```

```
digital_1();//display number 1
delay(2000);//delay 2 senconds
digital_2();
delay(2000);
digital_3();
delay(2000);
digital_4();
delay(2000);
digital_5();
delay(2000);
digital_6();
delay(2000);
digital_7();
delay(2000);
digital_8();
delay(2000);
}
}
```

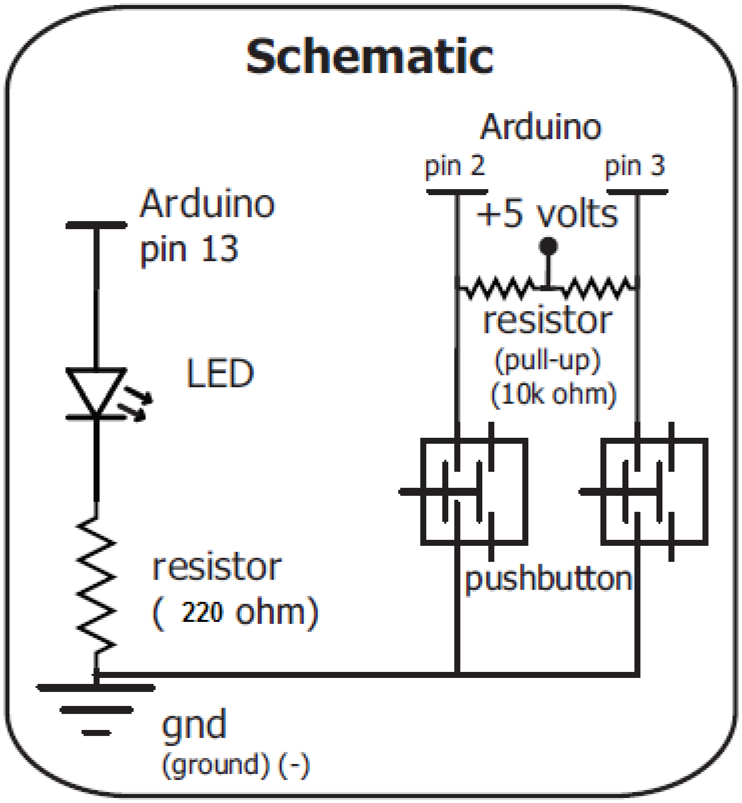
Lesson 4: Pushbuttons

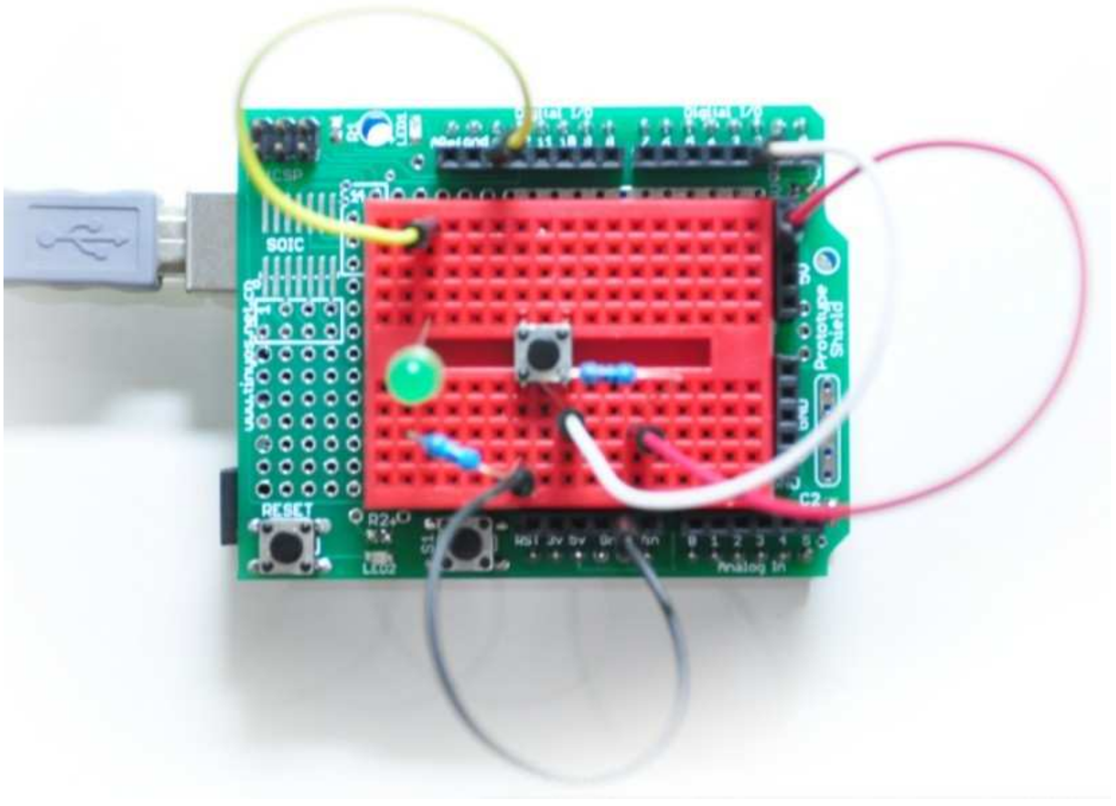
Up to this point we have focused entirely on outputs, time to get our Arduino to listen, watch and feel. We'll start with a simple pushbutton. Wiring up the pushbutton is simple. There is one component, the pull up resistor, that might seem out of place. This is included because an Arduino doesn't sense the same way we do (ie button pressed, button unpressed). Instead it looks at the voltage on the pin and decides whether it is HIGH or LOW. The button is set up to pull the Arduino's pin LOW when it is pressed, however, when the button is unpressed the voltage of the pin will float (causing occasional errors). To get the Arduino to reliably read the pin as HIGH when the button is unpressed, we add the pull up resistor.

THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1
- Pushbutton x1
- Jumper Wire x4
- 10K Ohm Resistor x1
- 220 Ohm Resistor x1
- Red LED x1


Schematic
Arduino
pin 2
pin 3
+5 volts
resistor
(pull-up)
(10k ohm)
pushbutton
Arduino
pin 13
LED
resistor
(220 ohm)
gnd
(ground) (-)



CODE

```
int ledPin = 13; // choose the pin for the LED

int inputPin = 2; // choose the input pin (for a pushbutton)

int val = 0; // variable for reading the pin status

void setup() {

pinMode(ledPin, OUTPUT); // declare LED as output

pinMode(inputPin, INPUT); // declare pushbutton as input

}

void loop(){

val = digitalRead(inputPin); // read input value

if (val == HIGH) { // check if the input is HIGH

digitalWrite(ledPin, LOW); // turn LED OFF

} else {

digitalWrite(ledPin, HIGH); // turn LED ON

}

}
```

Lesson 5: Light Sensor

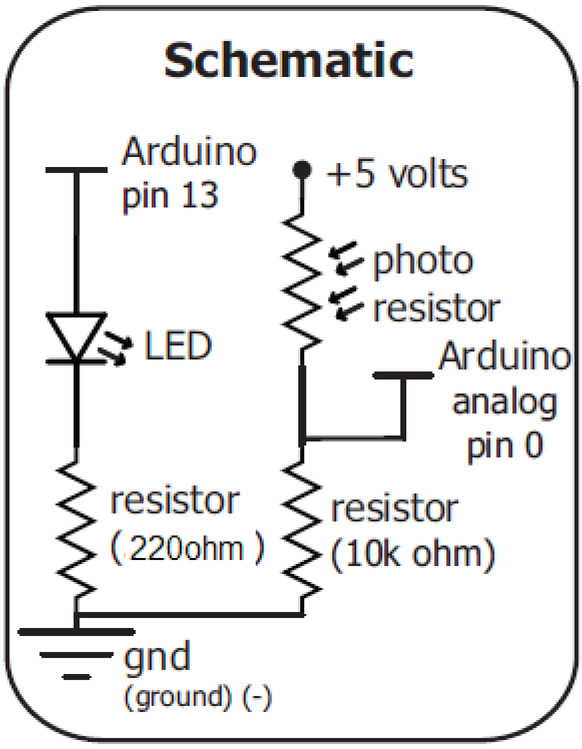
Whilst getting input from a potentiometer can be useful for human controlled experiments, what do we use when we want an environmentally controlled experiment? We use exactly the same principles but instead of a potentiometer (twist based resistance) we use a photo resistor (light based resistance). The Arduino cannot directly sense resistance (it senses voltage) so we set up a voltage divider . The exact voltage at the sensing pin is calculable, but for our purposes (just sensing relative light) we can experiment with the values and see what works for us. A low value will occur when the sensor is well lit while a high value will occur when it is in darkness.

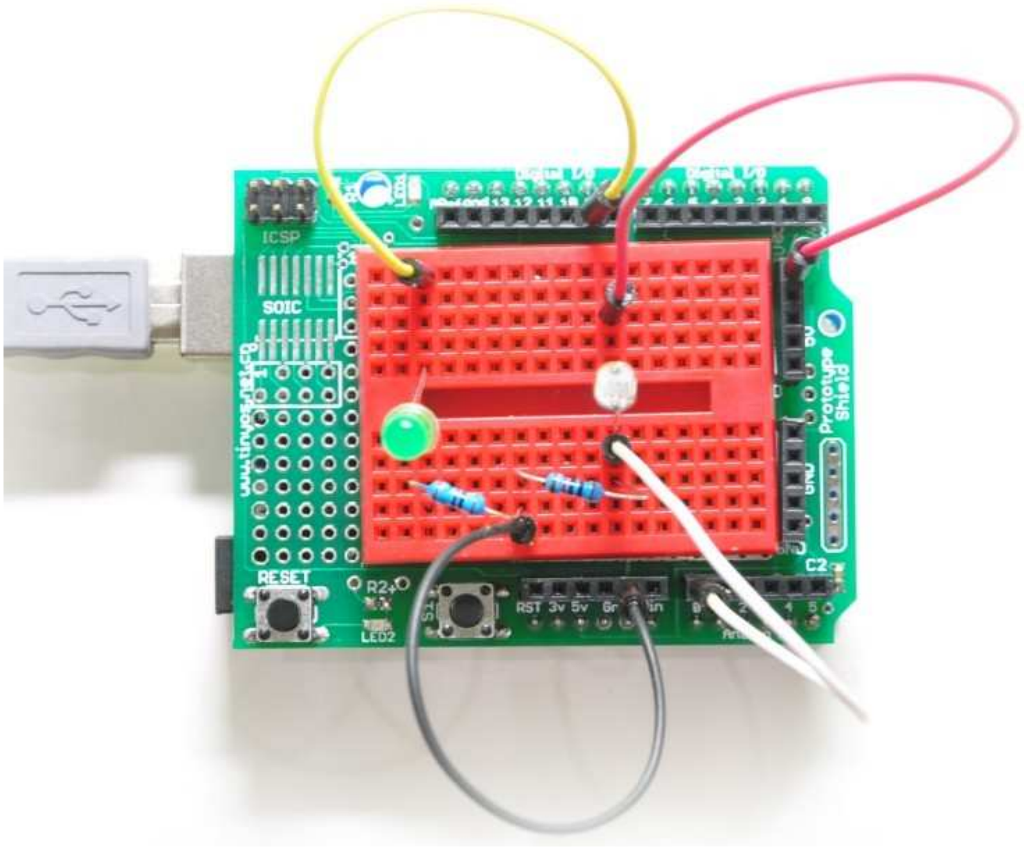
THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1

- Proto-Resistor x1
- Jumper Wire x4
- 10K Ohm Resistor x2
- 220 Ohm Resistor x1
- Green LED x1





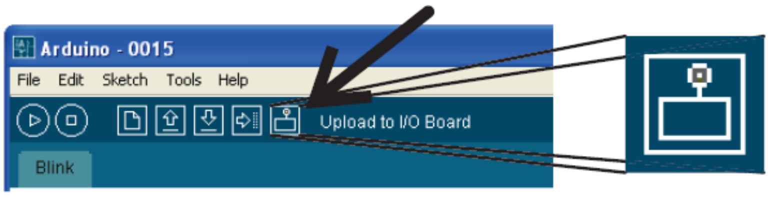
Code

```
/*
 * A simple programme that will change the intensity of
 * an LED based   * on the amount of light incident on
 * the photo resistor.
 *
 */

//PhotoResistor Pin
int lightPin = 0; //the analog pin the photoresistor is
                          //connected to
                          //the photoresistor is not calibrated to any units so
                          //this is simply a raw sensor value (relative light)
//LED Pin
int ledPin = 9;      //the pin the LED is connected to
                          //we are controlling brightness so
                          //we use one of the PWM (pulse width
                          // modulation pins)
void setup()
{
  pinMode(ledPin, OUTPUT); //sets the led pin to output
}
 /*
 * loop() - this function will start after setup
 * finishes and then repeat
 */
void loop()
{
 int lightLevel = analogRead(lightPin); //Read the
                                        // lightlevel
 lightLevel = map(lightLevel, 0, 900, 0, 255);
         //adjust the value 0 to 900 to
         //span 0 to 255



 lightLevel = constrain(lightLevel, 0, 255);//make sure the
                                           //value is betwween
                                           //0 and 255
 analogWrite(ledPin, lightLevel);   //write the value
}
```

Lesson 6: Temperature Sensor

What's the next phenomena we will measure with our Arduino? Temperature. To do this we'll use a rather complicated IC (integrated circuit) hidden in a package identical to our 8050 transistors. It has three pin's, ground, signal and +5 volts, and is easy to use. It outputs 10 millivolts per degree centigrade on the signal pin (to allow measuring temperatures below freezing there is a 500 mV offset eg. 25 C = 750 mV, 0). To convert this from the digital value to degrees, we will use some of the Arduino's math abilities. Then to display it we'll use one of the IDE's rather powerful features, the debug window. We'll output the value over a serial connection to display on the screen. Let's get to it.

One extra note, this circuit uses the Arduino IDE's serial monitor. To open this, first upload the program then click the button which looks like a square with an antennae.

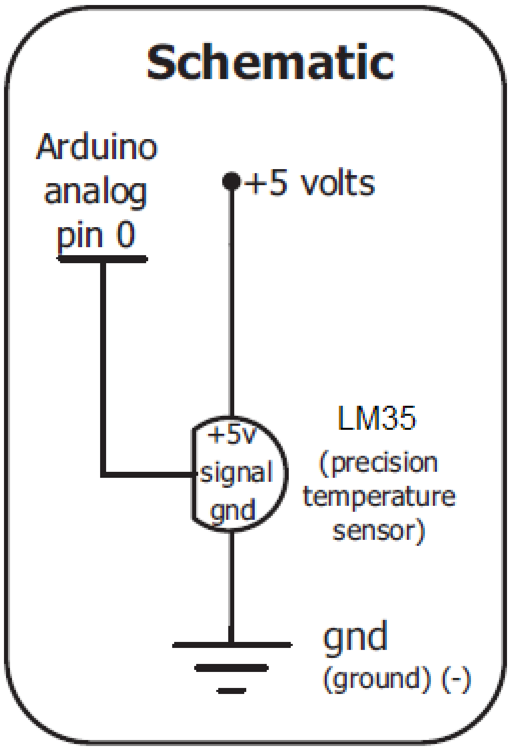


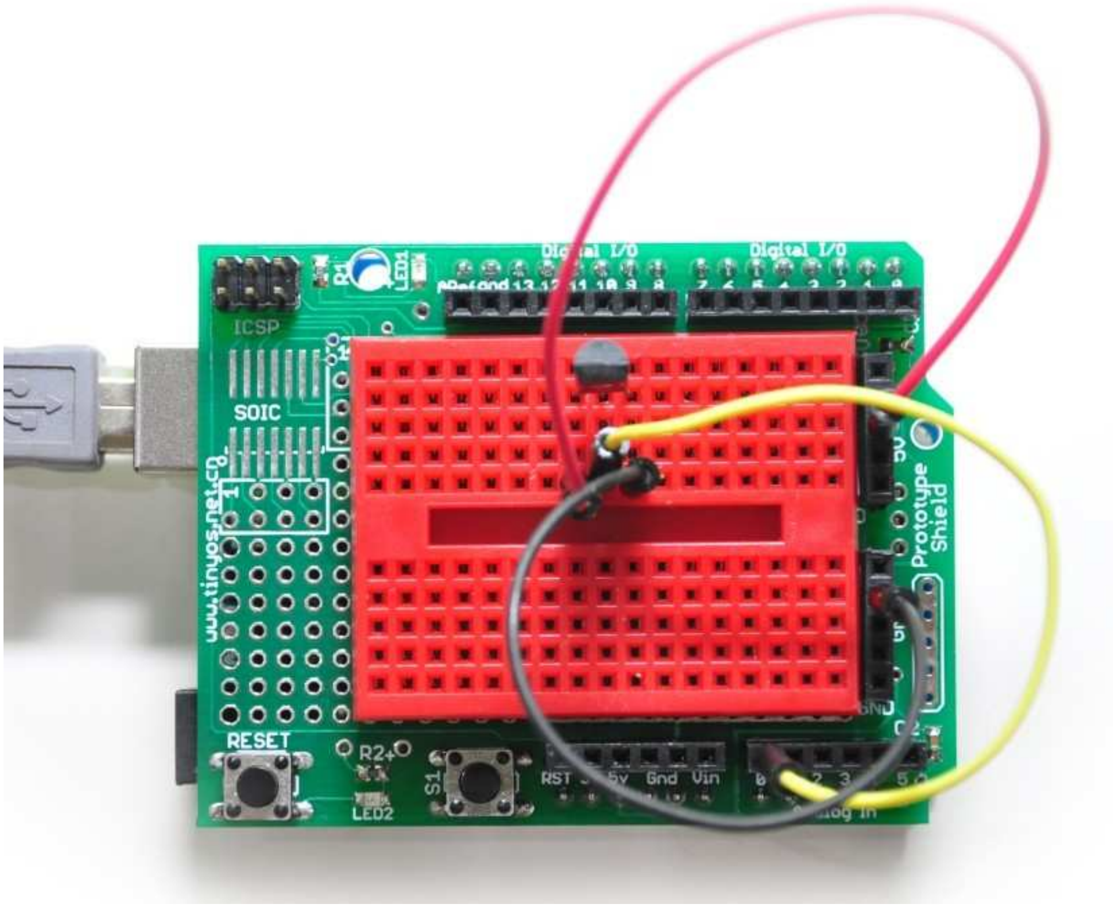
THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1

- Prototyping Shield x1
- Mini breadboard x1
- LM35 Temperature Sensor x1
- Jumper Wire x3





CODE

```
int temperaturePin = 0;
int tempc =0;
int samples[8];
int maxi=-100,mini=100;
int i;



/*
 * setup() - this function runs once when you turn your Arduino on
 * We initialize the serial connection with the computer
 */
void setup()
{
   Serial.begin(9600);    //Start the serial connection with the copmuter
                             //to view the result open the serial monitor
                             //last button beneath the file bar (looks like a box with an
antenae)
}
```

```
void loop()                             // run over and over again
{
 for(i=0;i<=7;i++)
 {
   samples[i]=(5.0*analogRead(temperaturePin)*100.0)/1024.0;
   tempc =tempc + samples[i];
   delay(100);
 }
 tempc =tempc/8.0;
 if(tempc>maxi){maxi =tempc;}
 if(tempc<mini){mini =tempc;}
 Serial.print(tempc,DEC);
 Serial.print(" Celsius ");
 Serial.print(maxi,DEC);
 Serial.print(" Max, ");
 Serial.print(mini,DEC);
 Serial.println(" Min ");
 tempc =0;
 delay(100);
}
```

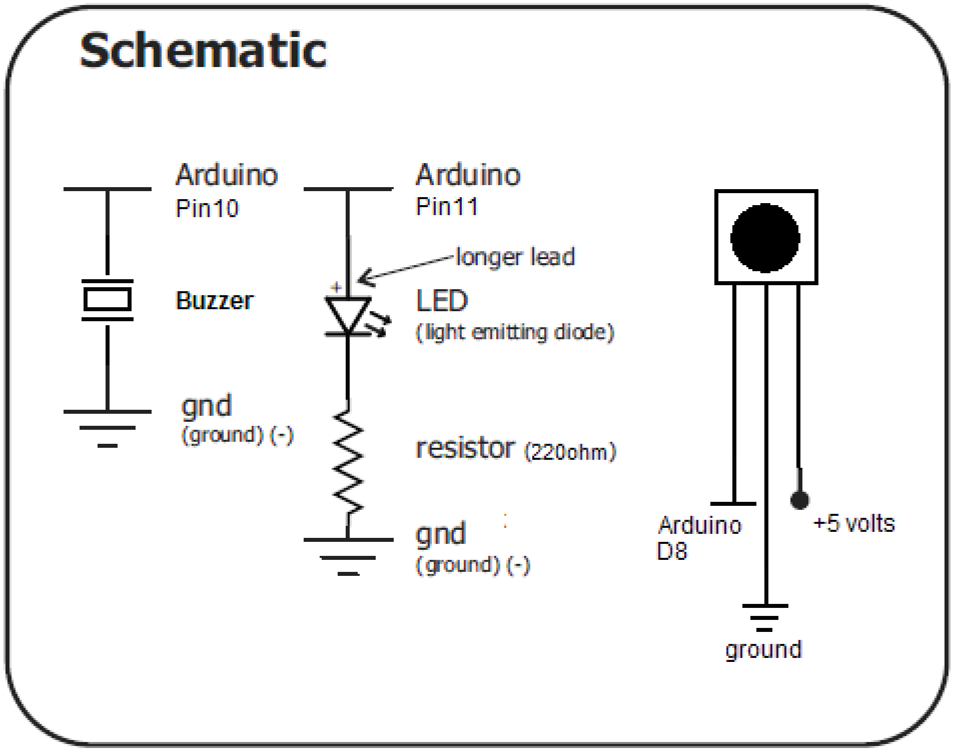
Lesson 7: IR Romote Control

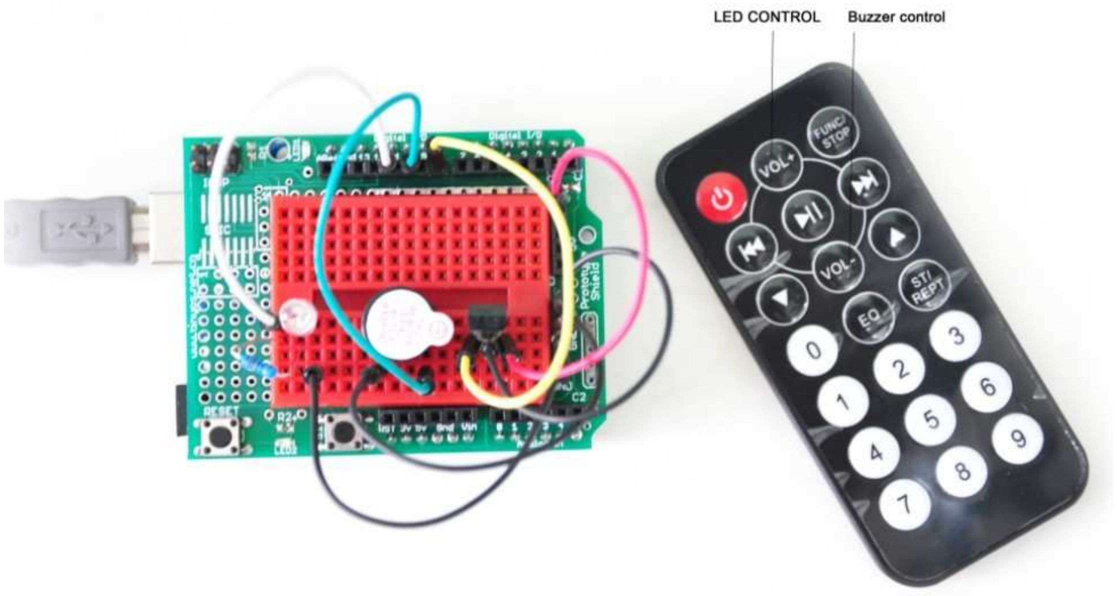
Wireless control? Cool! In this lesson we use a Infrared reveiver and a remote control to turn on a LED or a Buzzer. LED on when you press the VOL+ button and buzzer beep when you press the VOL- button. How to do that? Please follow me.

THE CIRCUIT:

Parts:

- Arduino UNO or MEGA2560 controller x1
- Prototyping Shield x1
- Mini breadboard x1
- IR Receiver x1
- Jumper wire x7
- 220 Ohm Resistor x1
- Buzzer x1
- Yellow LED x1





CODE

```
#define BUZZER 10//connect buzzer to digital pin 10
#define LED_RED 11//connect LED to digital pin 11
```

```
#define IR_IN   8   //connect the Infrared receiver to digital pin 8

int Pulse_Width=0; //pulse width
int   ir_code=0x00; //IR command code

void timer1_init(void) //initilize timer
{
  TCCR1A = 0X00;
  TCCR1B = 0X05;
  TCCR1C = 0X00;
  TCNT1 = 0X00;
  TIMSK1 = 0X00;
}
void remote_deal(void)   //get IR command
{
  switch(ir_code)
  {
  case 0xff00://press stop button on the remote controller
    digitalWrite(LED_RED,LOW);//turn off LED
    digitalWrite(BUZZER,LOW);//silence the buzzer
    break;
  case 0xfe01://VOL+
    digitalWrite(LED_RED,HIGH);//turn on led
    break;
  case 0xf609://VOL-
    digitalWrite(BUZZER,HIGH);//buzzer beep
    break;
  }
}
char logic_value()
{
  while(!(digitalRead(8)));
  Pulse_Width=TCNT1;
  TCNT1=0;
  if(Pulse_Width>=7&&Pulse_Width<=10)
  {
    while(digitalRead(8));
    Pulse_Width=TCNT1;
    TCNT1=0;
    if(Pulse_Width>=7&&Pulse_Width<=10)
      return 0;
    else if(Pulse_Width>=25&&Pulse_Width<=27)
      return 1;
  }
```

```
    return -1;
}
void pulse_deal()
{
    int i;
    for(i=0; i<8; i++)
    {
        if(logic_value() != 0)
                return;
    }
    for(i=0; i<6; i++)
    {
        if(logic_value()!= 1)
                return;
    }
    if(logic_value()!= 0)
            return;
    if(logic_value()!= 1)
            return;



    ir_code=0x00;
    for(i=0; i<16;i++ )
    {
        if(logic_value() == 1)
        {
            ir_code |=(1<<i);
        }
    }
}
void remote_decode(void)
{
    TCNT1=0X00;
    while(digitalRead(8))
    {
        if(TCNT1>=1563)
        {
            ir_code = 0xff00;
            return;
        }
    }
    TCNT1=0X00;

    while(!(digitalRead(8)));
    Pulse_Width=TCNT1;
    TCNT1=0;
    if(Pulse_Width>=140&&Pulse_Width<=141)//9ms
    {

        while(digitalRead(8));
        Pulse_Width=TCNT1;
        TCNT1=0;
        if(Pulse_Width>=68&&Pulse_Width<=72)
        {
            pulse_deal();
            return;
        }
        else if(Pulse_Width>=34&&Pulse_Width<=36)//2.25ms
        {
            while(!(digitalRead(8)));
            Pulse_Width=TCNT1;
            TCNT1=0;
            if(Pulse_Width>=7&&Pulse_Width<=10)//560us
            {
                return;
            }
        }
    }
}
void setup()
{
    unsigned char i;
    pinMode(LED_RED,OUTPUT);
    pinMode(BUZZER,OUTPUT);
    pinMode(IR_IN,INPUT);
}
void loop()
{
    timer1_init();
    while(1)
    {
        remote_decode();
        remote_deal();
    }
}
```