LED Strips for Everyone Everywhere

Mitch Altman

Chief Scientist, Cornfield Electronics, San Francisco, CA
Inventor of TV-B-Gone universal remote controls
Co-founder of 3Ware (successful Silicon Valley startup)
Pioneer of VR (in the mid-1980s)
Founding mentor at HAX (1st and biggest hardware accelerator)
Co-founder of Noisebridge (San Francisco hackerspace)

email: mitch@CornfieldElectronics.com
site: www.CornfieldElectronics.com
twitter: @maltman23
flickr: maltman23
WeChat: mitchaltman
LED Strips for Everyone Everywhere
Syllabus

• Intro to LEDs
• A bit about electronics
• RGB color theory
• A bit about Arduino
• PWM basics
• Programming RGB LED strips
• Ordering RGB LED strips
LEDs

Lots of different colored LEDs!
A Little About Electronics
A Little About Electronics

Electrons

Electrons
A Little About Electronics

Circuit = Electrons going in complete circle = Magic!
A Little About Electronics

Power Supplies
Everything You Need to Know About Electronics

Voltage / Volts
Everything You Need to Know About Electronics

Speed of electrons is Current measured in Amps

Electrons pushed with 1.5V. So, they move!
Everything You Need to Know About Electronics

The speed of electrons is measured in Amps.

3 times more Volts
3 times more push
3 times faster electrons
3 times more current / Amps

Current / Amps
Everything You Need to Know About Electronics

Too much energy?

Lots of energy!

Current / Amps
Everything You Need to Know About Electronics

Speed of electrons is Current measured in Amps

Resistance in the electrons’ path slows them down, which means less current (less Amps).

Resistance / Ohms
A Little About Electronics

Ohm’s Law

Volts -- force pushing electrons

Amps -- speed of electrons

Ohms -- Resistance to flow of electrons
A Little About Electronics

Ohm’s Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

**Ohms** -- *Resistance* to flow of electrons

\[ \text{Volts} = \text{Amps} \times \text{Ohms} \]
A Little About Electronics

What happens?

Power Supply – it matters how you connect it!
LED

Plus / Positive (+)

Minus / Negative (-)
A Little About Electronics

Power Supply – it matters how you connect it!

Black Wire = “-”

Red Wire = “+”

4.5V
A Little About Electronics

Power Supply – it matters how you connect it!

Red wire:
- Power,
- Plus, Positive,
- 4.5V, Vcc

Black wire:
- Minus, Negative,
- 0V, Ground (GND)
A Little About Electronics

Lots of different colored LEDs!

LED
More current → More brightness! (until...)
Everything You Need to Know About Electronics

More current → More brightness! (until...)
This is why we put a resistor in line with an LED (with a resistor so no magic smoke goes away).
LED Brightness

- Red (+) wire connected to the + lead of the battery holder.
- Black (-) wire from the LED lead connected to the resistor.
- Resistor connected to the long lead.
- Short lead of the LED connected to the 2xAA Battery holder with on/off switch.
LED Brightness

Less resistance
But, we will use:

PWM

*(coming soon)*
Lighting an LED

LED & battery
Light Color Mixing
Light Color Mixing

B: (0, 0, 255)

White: (255, 255, 255)

R: (255, 0, 0)

G: (0, 255, 0)
RGB LED

R+ B+ G+

Common GND (-)
RGB LED with microcontroller (Example)
Intro to Arduino
Intro to Arduino

Use an Arduino board

Super easy to connect parts to its microcontroller’s pins
Intro to Arduino

Use an Arduino board

Super easy to connect parts to its microcontroller’s pins

Super easy to create and upload a program to control the parts
Intro to Arduino

Open Source
Intro to Arduino

Arduino Nano “clone”
Intro to Arduino

hundreds of thousands of projects online!
Intro to Arduino

Arduino For Total Newbies workshop

Day 3 Tuesday 29-December, 13:00 to 16:30

Right-click on this link, and open in a new window:
Arduino For Total Newbies workshop room on Big Blue

NOTE: You do NOT need to register to take this workshop.
Just show up before the start time at the Big Blue Button room,
given above.

Learn Arduino
using TV-B-Gone
as an example project
(no materials required)
For more info, there are many good Arduino tutorials online. A good place to start is:

Arduino

First:
Download and install the Arduino software
< http://arduino.cc >
Second:
Download Arduino sketches
Search for: “RGB LED Strip Sketches”

Store them on your computer anywhere you like.
Connect your Arduino to your computer
Connect your Arduino to your computer
Serial Port Driver

You may need to download and install a driver for your Operating System (Windows, MacOS, or Linux):
After you download and install the Arduino software start it, and you will see a screen that looks like this:
Arduino

The first time you start your Arduino software you need to set things up

(1) Choose “Arduino Nano” as the Board
Arduino

The first time you start your Arduino software you need to set things up

(2) Choose your Processor as the Board

If this one doesn’t work, then choose “ATmega328P (Old Bootloader)”
(3) Choose the Port (this will be different depending on your Operating System)

First: Tools → Port without USB cable plugged in

In this example we see only: COM3 and COM4
Arduino

The first time you start your Arduino software you need to set things up

(3) Choose the Port (this will be different depending on your Operating System)

(After installing the driver for your Arduino (USB-Serial adapter), with your Arduino plugged in, your operating system will see a serial port and it appears here.)

Second: Tools → Port with USB cable plugged in
In this example we now also see: COM18
Arduino

The first time you start your Arduino software you need to set things up

(4a) Install the Neopixel library
The first time you start your Arduino software, you need to set things up.

(4b) Install the Neopixel library
Arduino

Your Arduino software is now ready to program your Arduino board!

```cpp
void setup() {
    // put your setup code here, to run once:
}

void loop() {
    // put your main code here, to run repeatedly:
}
```
Arduino

Designed for non-geeky artists

“Sketch”:

an Arduino program
Arduino

Let’s start simple!

Let’s all make an LED blink!
Arduino

Example “sketch”: Blink

```cpp
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);  // turn the LED on (HIGH is the voltage level)
  delay(1000);
  // wait for a second
  digitalWrite(LED_BUILTIN, LOW);   // turn the LED off by making the voltage LOW
  delay(1000);
}  
```

This example code is in the public domain.

Arduino

With the USB cable connected to your Arduino board, press the Upload button.
While uploading, you will see a progress bar...

…and when it’s completed successfully, it says: “Upload done”
LED Brightness

More resistance (less current)

(one way to change brightness)
LED Brightness

Less *average* current

This is how we do it with a microcontroller
LED Brightness

PWM
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/Blink
*/

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                      // wait for a second
  digitalWrite(LED_BUILTIN, LOW);   // turn the LED off by making the voltage LOW
  delay(1000);                      // wait for a second
}
LED Brightness

Square Wave:
ON half the time / OFF half of the time
ON half the time / OFF half of the time

Square Wave:
ON half the time / OFF half of the time

(half the energy of ON all the time)
Digital Signal Processing

Pulse Wave:
ON and OFF at any ratio you like

This waveform: ON for 25% of the time / OFF for 75% of the time
LED Brightness

Pulse Wave:
ON and OFF at any ratio you like

PWM

Pulse Width Modulation

- 0% Duty Cycle
- 25% Duty Cycle
- 50% Duty Cycle
- 75% Duty Cycle
- 100% Duty Cycle
LED Brightness

PWM
Pulse Width Modulation
Example “sketch”: Fade

```c
#include <FastLED.h>

const int led = 9; // the PWM pin the LED is attached to
const int brightness = 0; // how bright the LED is
const int fadeAmount = 5; // how many points to fade the LED by

void setup()
{
  // declare pin 9 to be an output:
  pinMode(led, OUTPUT);
}

void loop()
{
  for (int i = 0; i < fadeAmount; i++)
  {
    analogWrite(led, brightness + ((i * 255) / fadeAmount));
    delay(100);
  }
  for (int i = fadeAmount - 1; i > 0; i--)
  {
    analogWrite(led, brightness - ((i * 255) / fadeAmount));
    delay(100);
  }
}
```

This example shows how to fade an LED on pin 9 using the `analogWrite()` function.

The `analogWrite()` function uses PWM, so if you want to change the pin you're using, be sure to use another PWM capable pin. On most Arduino, the PWM pins are identified with a "~" sign, like ~3, ~5, ~6, ~9, ~10 and ~11.

This example code is in the public domain.


/*

 Sketch uses 1144 bytes (3%) of program storage space. Maximum is 32256 bytes.
 Global variables use 13 bytes (0%) of dynamic memory, leaving 2035 bytes for local variable
*/
Let’s Program Some LED Strips!
Arduino
Arduino
Let’s Program Some LED Strips!

Connector at end of Cable from LED strip

Red wire
Green wire
White wire

LED strip

5V
A5
GND

To Arduino

← LED strip
Let’s Program Some LED Strips!

Download some Arduino “sketches”:

Search for:  “RGB LED Strip Sketches”

Store them on your computer anywhere you like.
Let’s Program Some LED Strips!

Download some Arduino “sketches”:

https://CornfieldElectronics.com/cfe/projects.php#ledstrips
Let’s Program Some LED Strips!

Open the “sketch” you want to program

```cpp
// NeoPixel_36C3_Hanging_LEDs

// A highly configurable Knight Rider (larson display) routine for your NeoPixels
```
Let’s Program Some LED Strips!

With the USB cable connected to your Arduino board press the Upload button

```
NeoPixel_36C3_Hanging_LEDs

// A highly configurable Knight Rider (larson display) routine for your NeoPixels
```
Let’s Program Some LED Strips!

While uploading, you will see a progress bar...

...and when it’s completed successfully, it says: “Upload done”
Ordering LED Strips
Ordering LED Strips
LED Strips for Everyone Everywhere

These slides are also available at:

https://CornfieldElectronics.com/cfe/projects.php#ledstrips
LED Strips for Everyone Everywhere

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twitter: **@maltman23**
flickr: **maltman23**
WeChat: **mitchaltman**