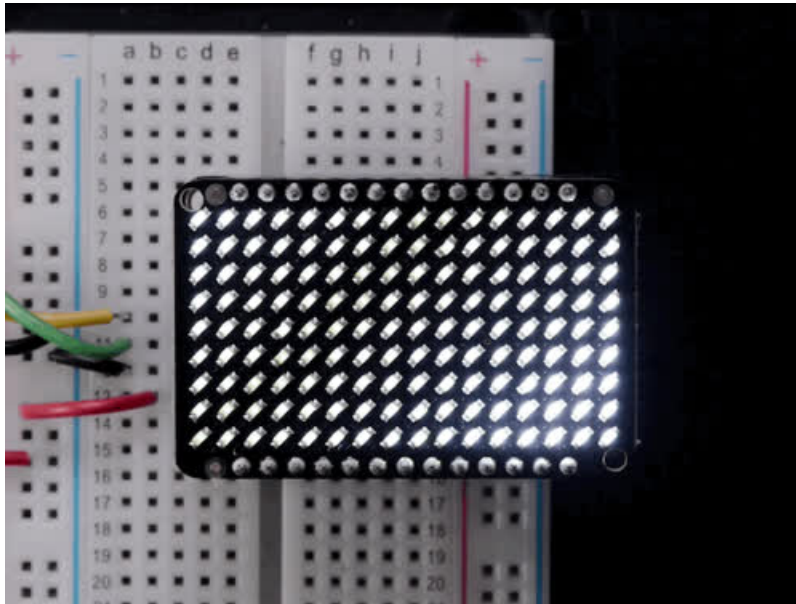


IS31FL3731 16x9 Charlieplexed PWM LED Driver

Created by lady ada

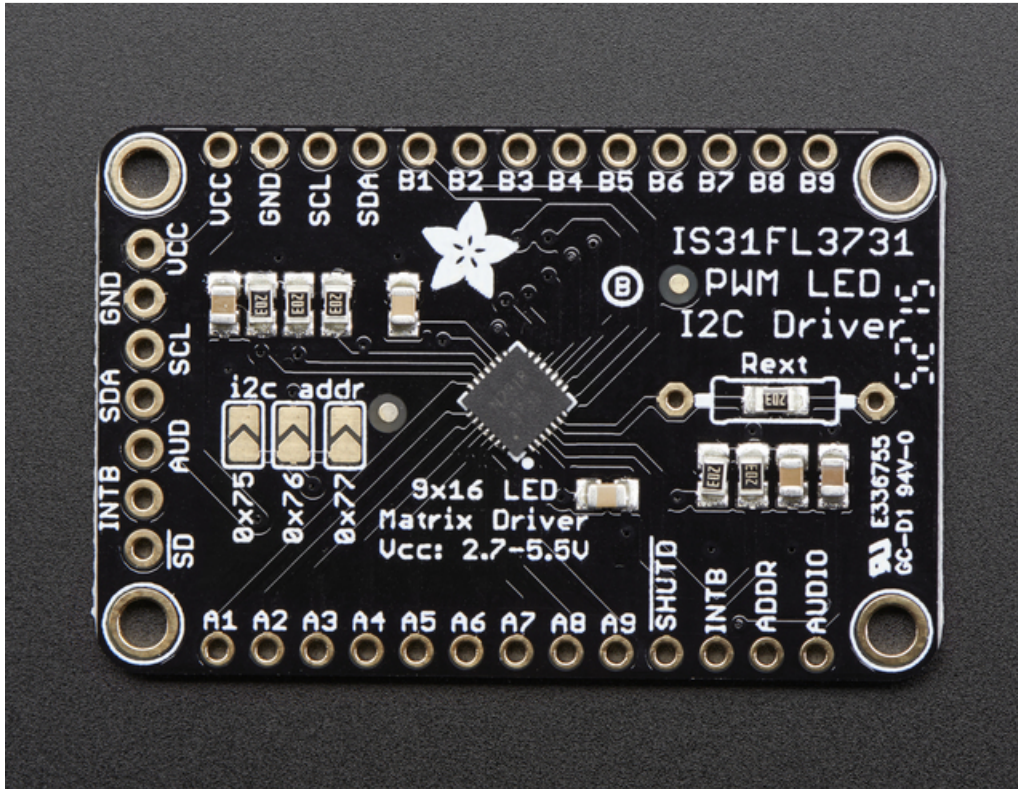


Last updated on 2018-01-10 06:31:05 PM UTC

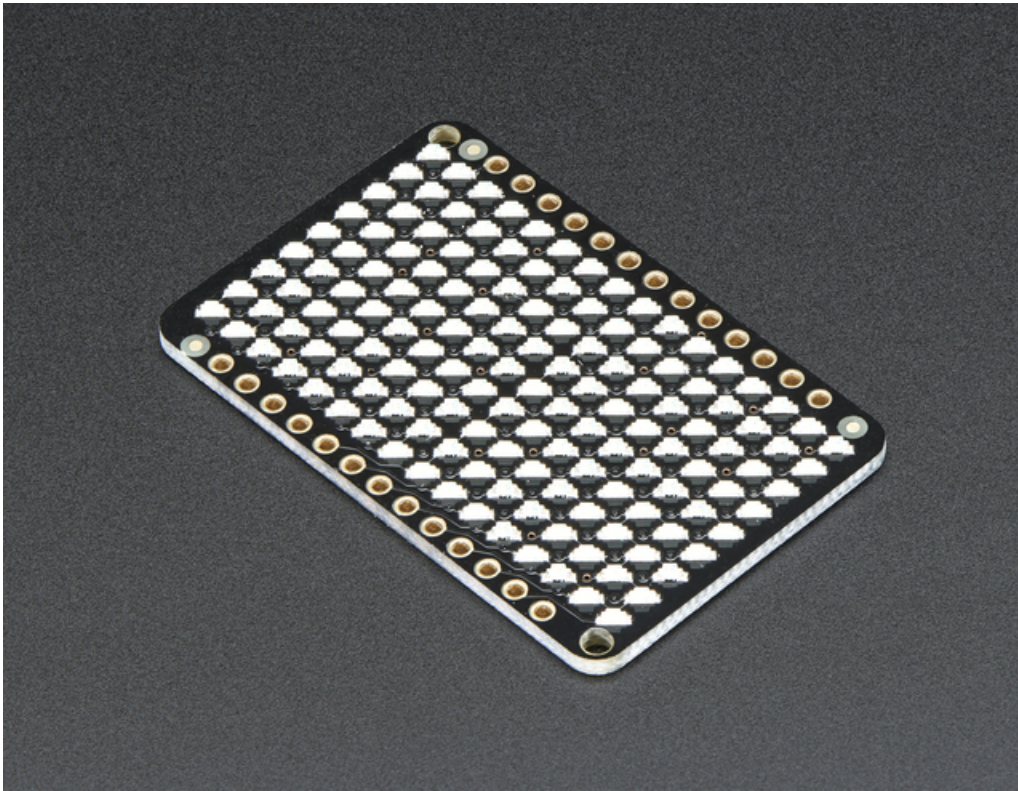
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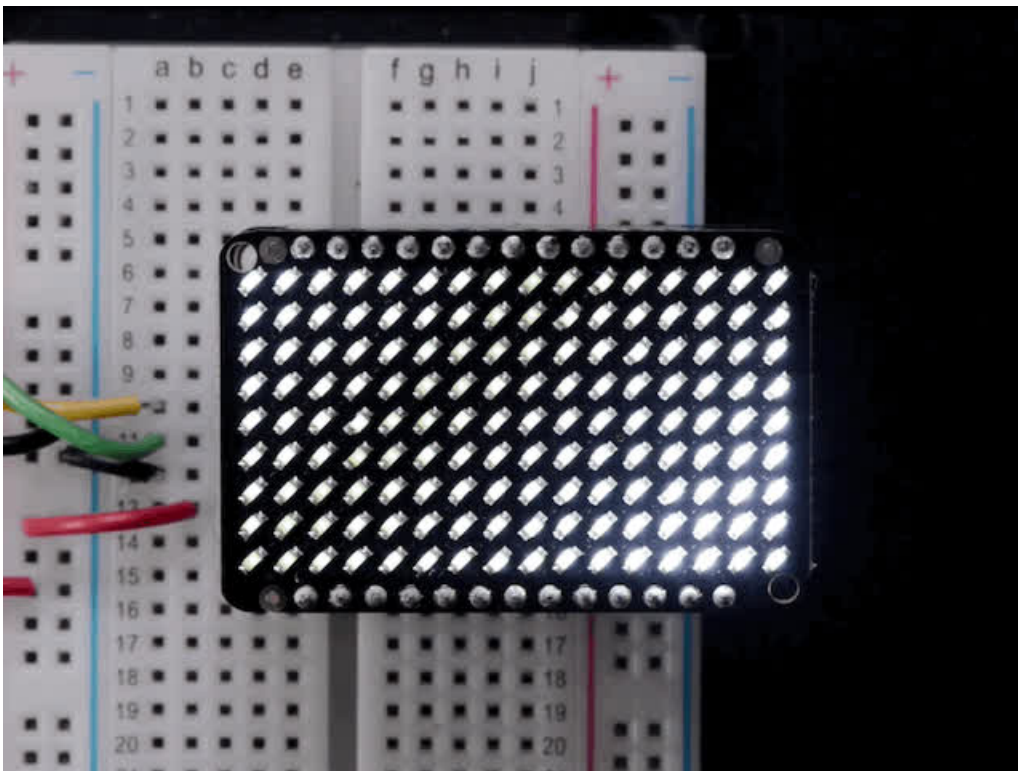
Overview



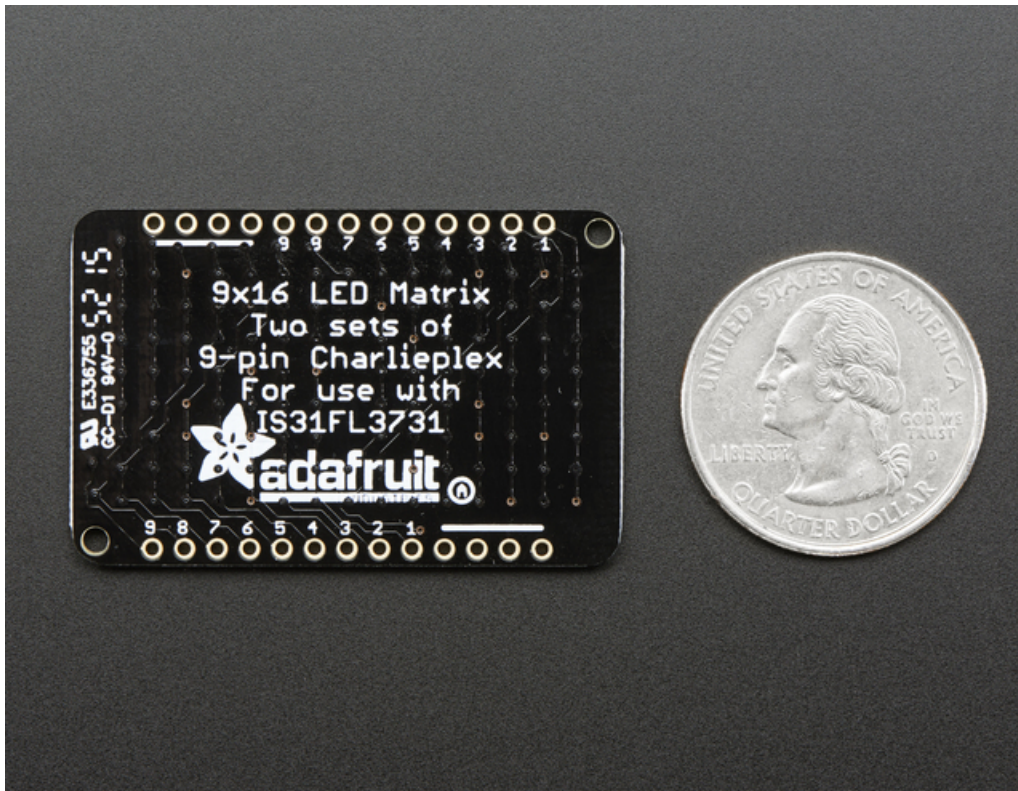
The IS31FL3731 will let you get back to that classic LED matrix look, with a nice upgrade! This I2C LED driver chip has the ability to PWM each individual LED in a 16x9 grid so you can have beautiful lighting effects, without a lot of pin twiddling. Simply tell the chip which LED on the grid you want lit, and what brightness and it's all taken care of for you.



The IS31FL3731 is a nice little chip - it can use 2.7-5.5V power and logic so its flexible for use with any microcontroller. You can set the address so up to 4 matrices can share an I2C bus. Inside is enough RAM for 8 separate frames of display memory so you can set up multiple frames of an animation and flip them to be displayed with a single command.

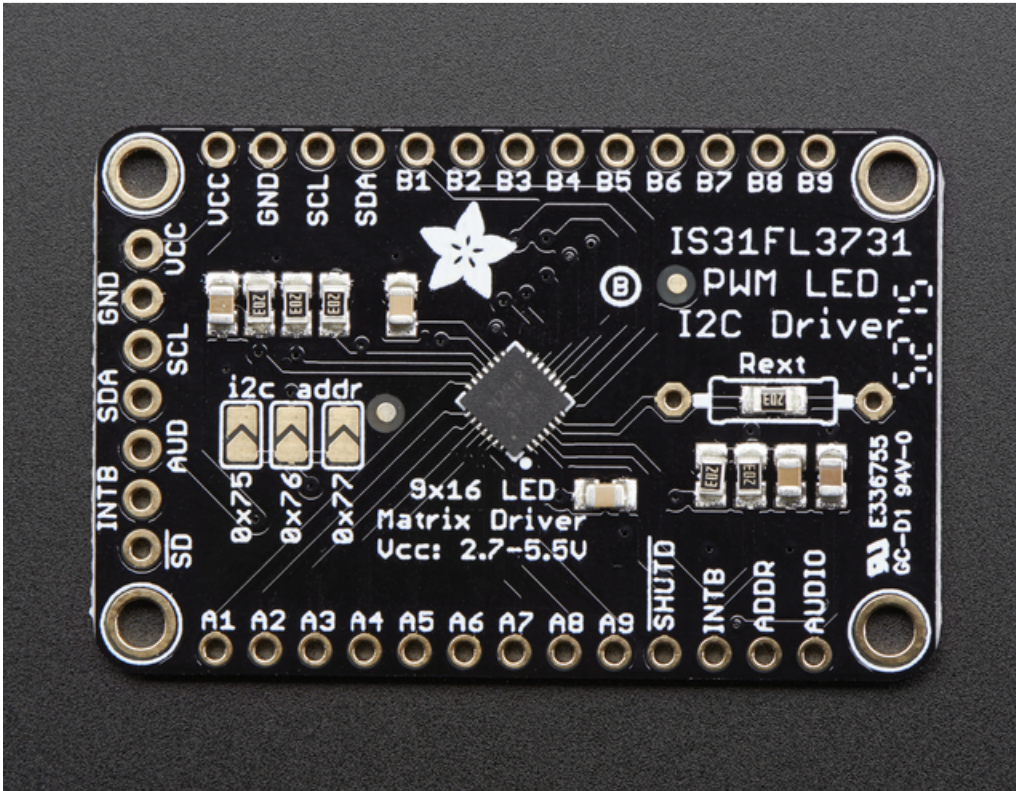


This chip is great for making small LED displays, and we even designed the breakout to match up with our ready-to-go LED grids in red, yellow, green, blue and white. Sandwich the driver and matrix breakout, solder together for a compact setup. Or you can DIY your own setup, just follow the LED grid schematic in the IS31FL3731 datasheet.



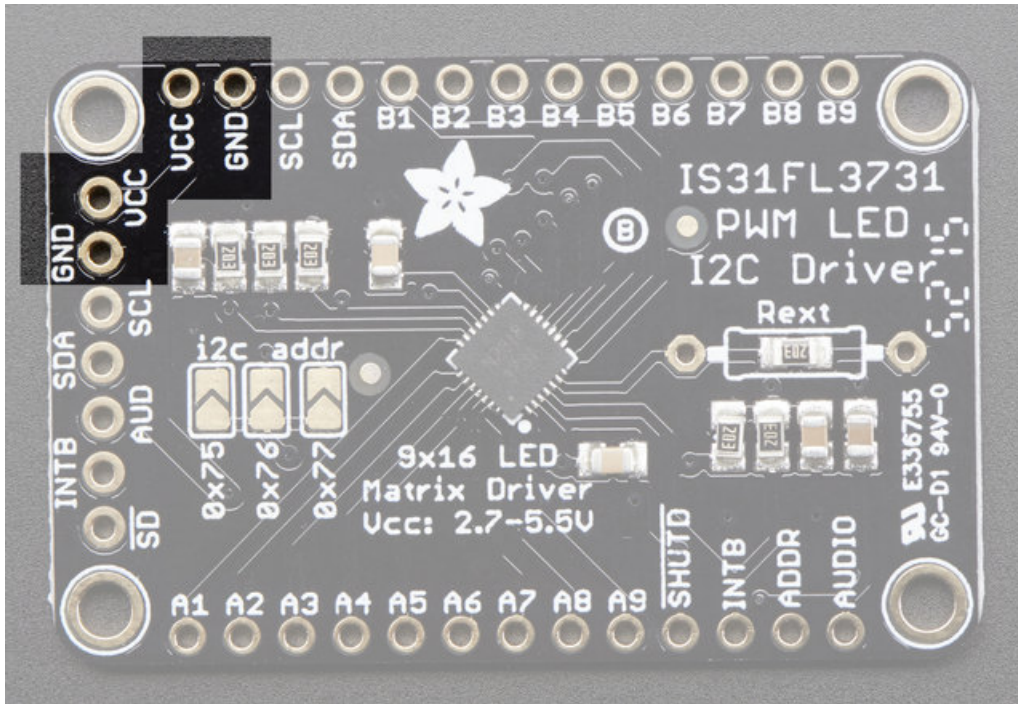
Pick up a driver board and your favorite color LEDs to match. You'll need to do some basic soldering to attach the driver backpack and matrix together, and run wires to your microcontroller, but its not too hard. Then install our Arduino code to get some LEDs blinking immediately. Our library is Adafruit_GFX compatible so you can draw lines, circles, text, and small bitmaps if you want more graphics control

Pinouts



The IS31FL3731 has a lot of pins, and we wanted to make it easy to use with a breadboard while sandwiched with an LED matrix. The easiest way we could figure out to do this is make the board as large as our 0603-LED 16x9 matrix grids and have a control header on one edge. That way you can solder the two long headers directly to the matrix and still have access to pins for power and data.

Power Pins

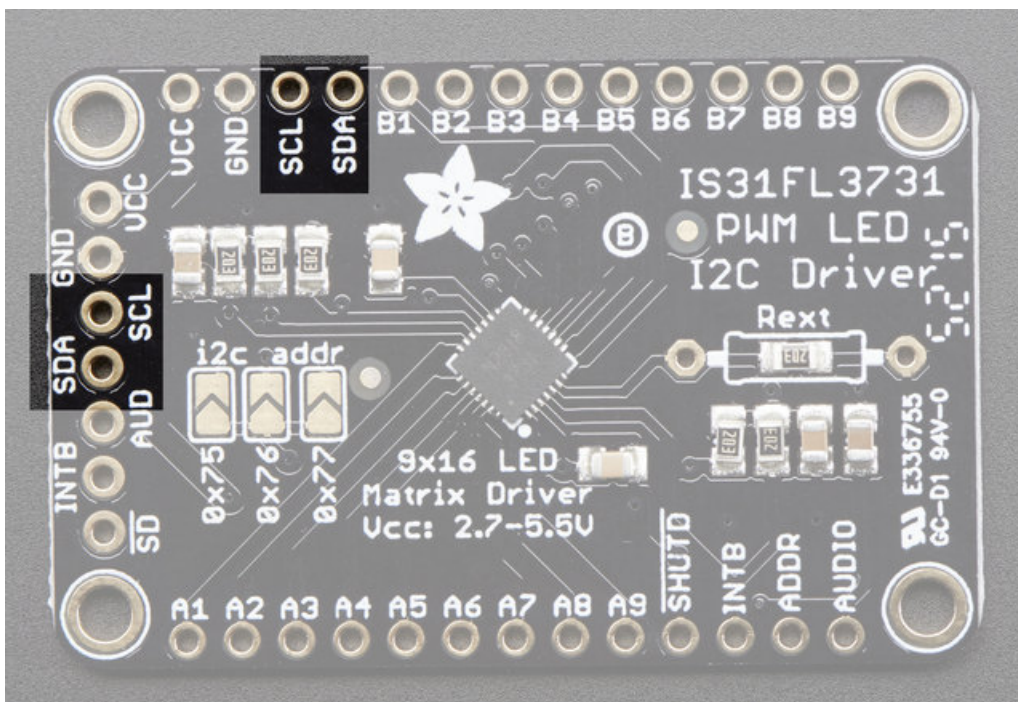


You can power the IS31 from 2.7-5.5VDC, but note that the same voltage is used for both power and logic.

If you are using a **5V** logic device, just connect **VCC** to 5V.

If you are using a **3.3V** logic, you can either power with 3.3V, which will work fine for red, yellow or light green LEDs *or* you can power from 5V and then use ~2.2K resistors from SDA and SCL to 3.3V to 'overpower' the built in 20K pullup resistors.

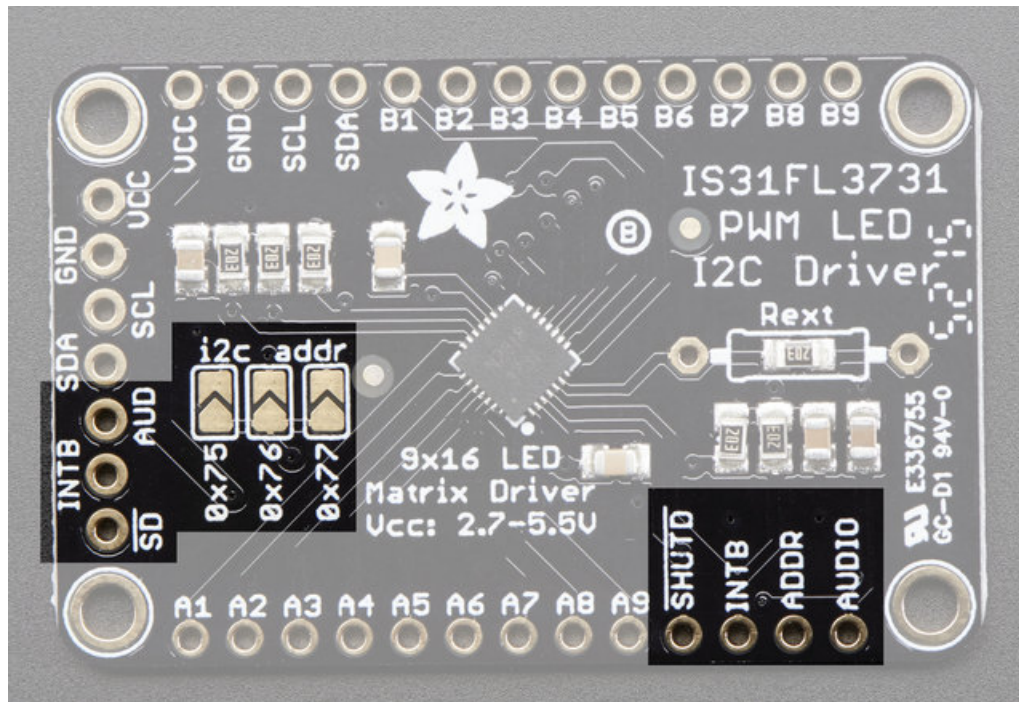
I2C Data Pins



This chip uses I2C for control, it does not use clock stretching or repeated start. There are built in 20K pullups to VCC. You can run it as fast as 400KHz clock speed, but you may need to add additional 2K pullups from SDA and SCL up to VCC for higher speeds

- **SDA** - I2C data line, connect to your microcontroller's I2C SDA pin
- **SCL** - I2C clock line, connect to your microcontroller's I2C SCL pin

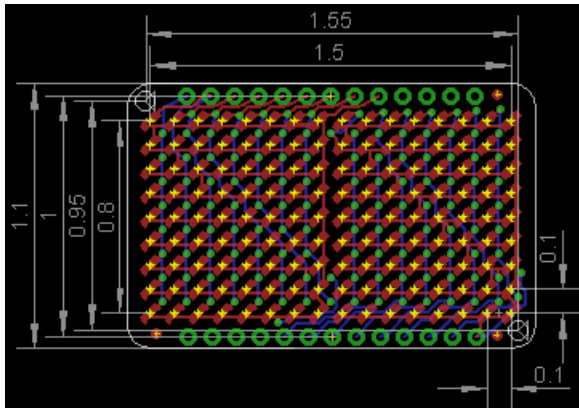
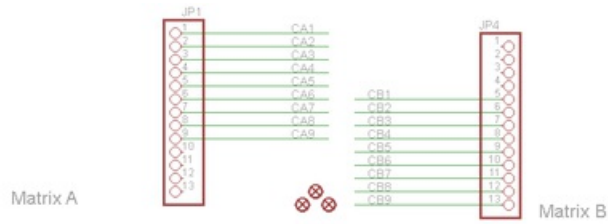
Other Control Pins



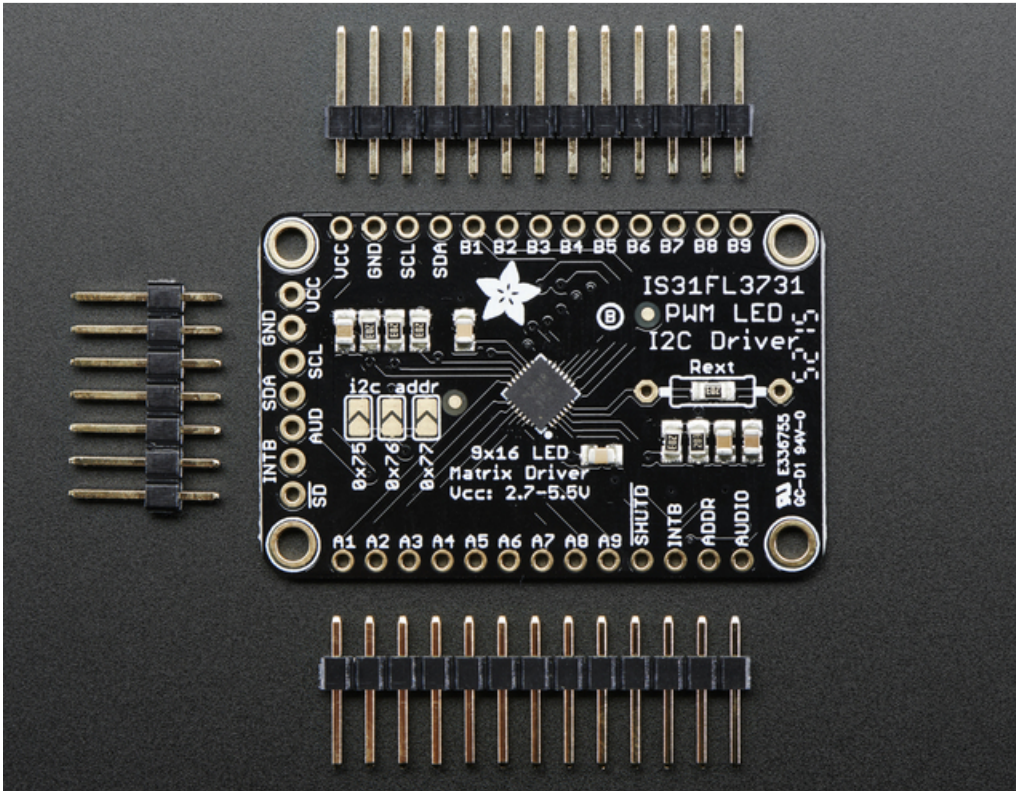
- **SD** - Shutdown pin, default pulled up to VCC. Connect to ground to put the chip in shutdown mode
- **AUD** - Audio input, can be used to modulate the entire display with the amplitude of a line level audio signal, has a series capacitor installed.
- **ADDR** and **jumper**s - By default the address is **0x74** but you can close **one** of the jumpers to change the address for up to 4 devices with varying addresses
- **INTB** - Output interrupt from chip when using the built in animation modes

LED Grid

The LED Grid is much simpler, it just has 2 charlieplex grids, 16x9 total 0603 LEDs, with the two grids broken out to side pins that line up with the driver

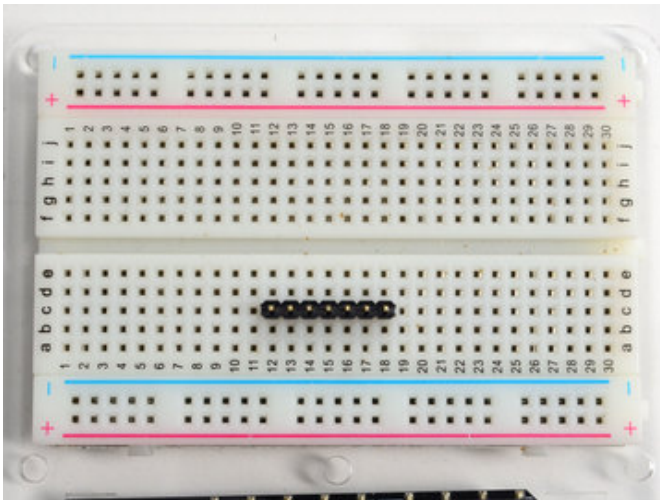


Assembly



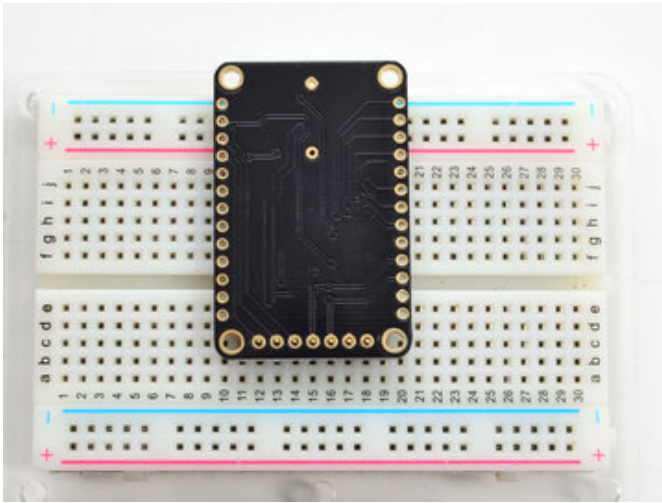
Assemble the IS31 Driver Board

We'll start by soldering in the 7-pin 'control' header. Break the headers you received so that you have a 7-pin piece and follow these steps.

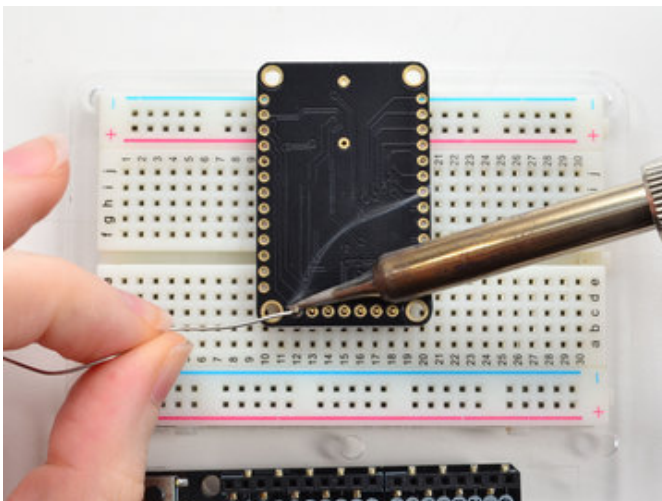


Prepare the header strip:

Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - long pins down

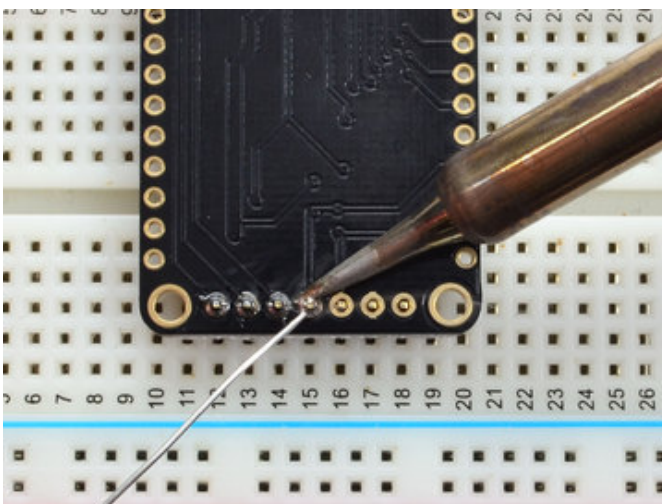


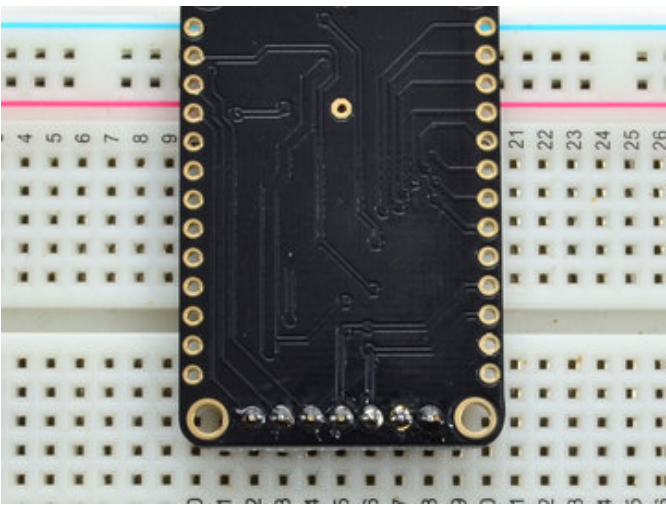
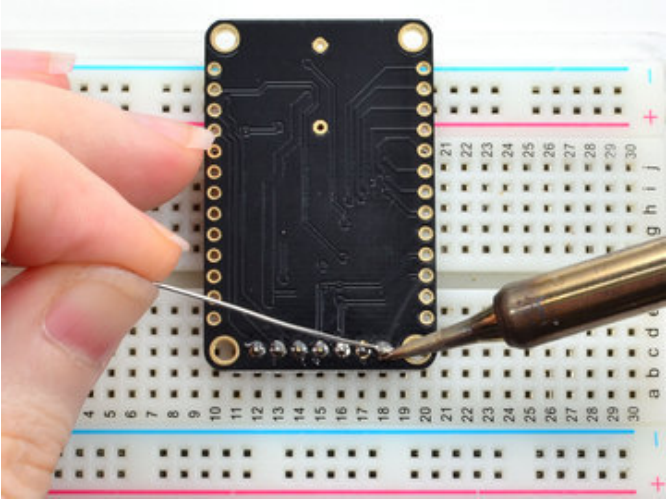
Add the breakout board:
Place the breakout board over the pins so that the short pins poke through the breakout pads



And Solder!
Be sure to solder all pins for reliable electrical contact.

(For tips on soldering, be sure to check out our [Guide to Excellent Soldering](https://adafruit.it/aTk) (<https://adafruit.it/aTk>)).



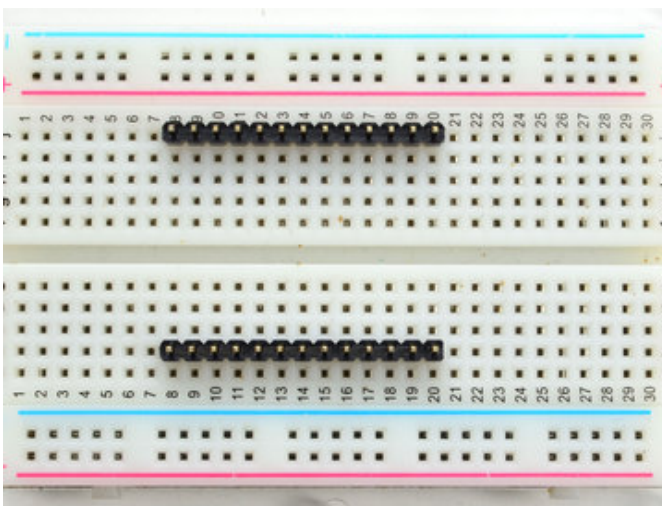


OK the control port header is done.

Check your solder joints visually and continue onto the next steps

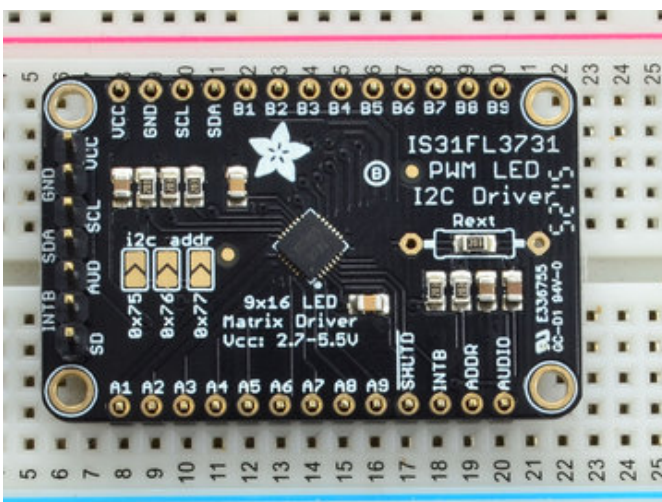
Solder Driver Headers for LEDs

The two side strips are what are used to control the charlie-plexed LEDs



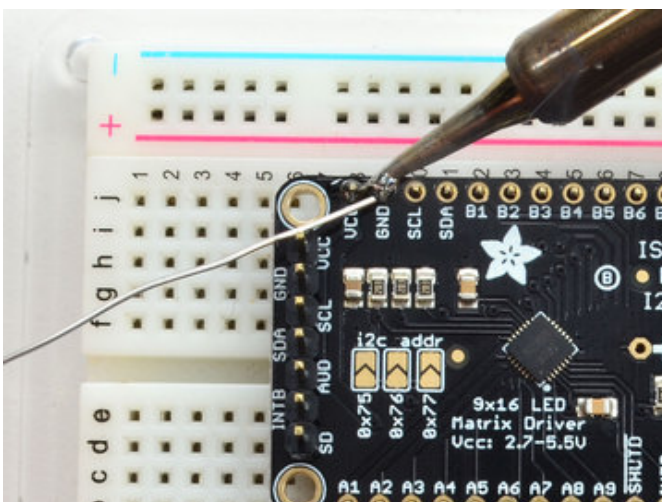
Prepare the header strip:

Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - **long pins down**



Add the breakout board face up:

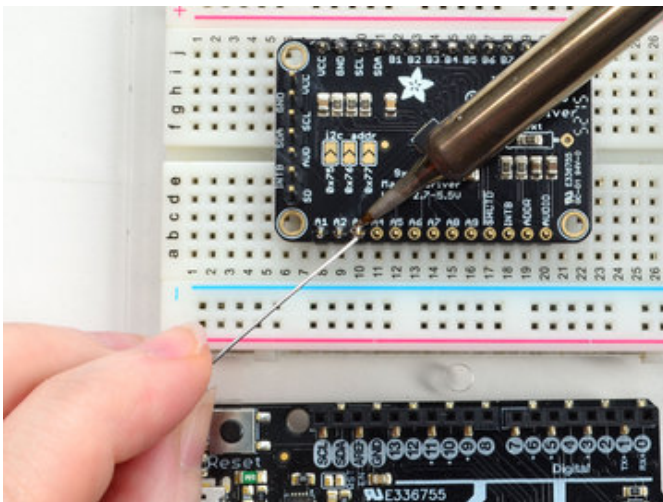
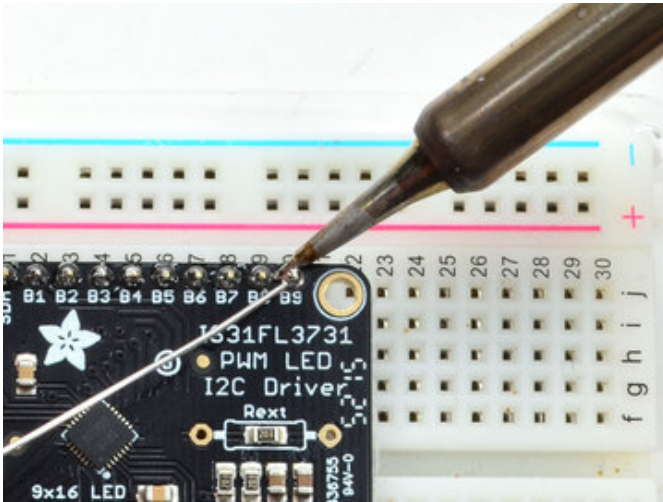
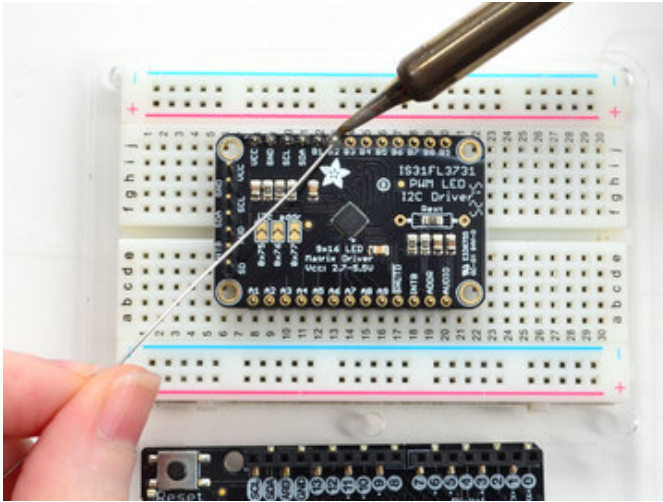
Place the breakout board over the pins so that the short pins poke through the breakout pads

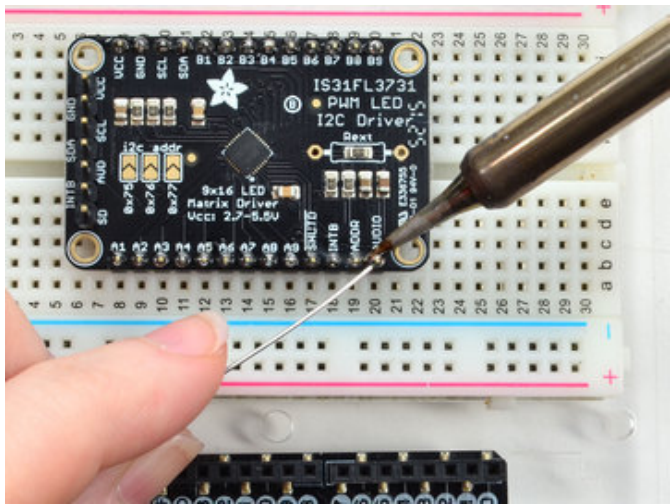
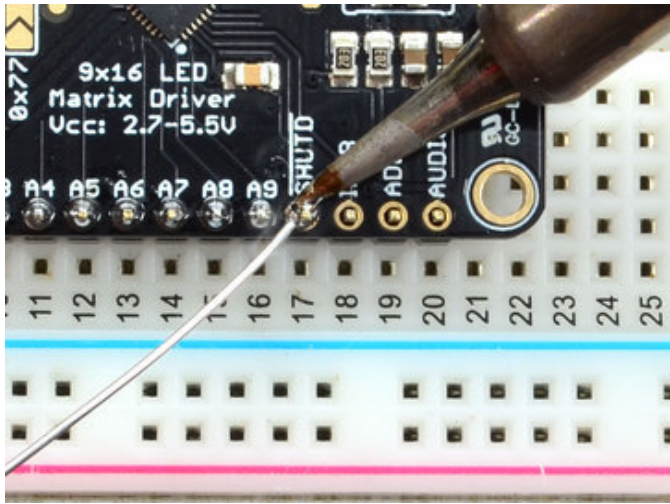


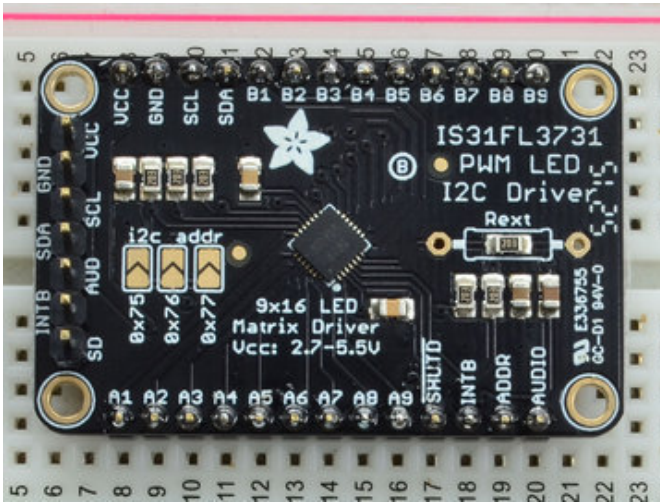
And Solder!

Be sure to solder all pins for reliable electrical contact.

(For tips on soldering, be sure to check out our [Guide to Excellent Soldering](https://adafruit.com/guides/excellent-soldering) (<https://adafruit.com/guides/excellent-soldering>)).





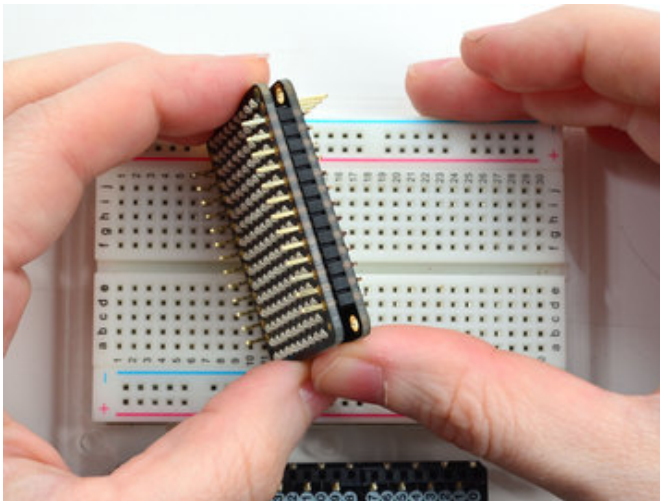


OK now you have the control *and* LED pads with headers.

Check your solder joints visually and continue onto the next steps

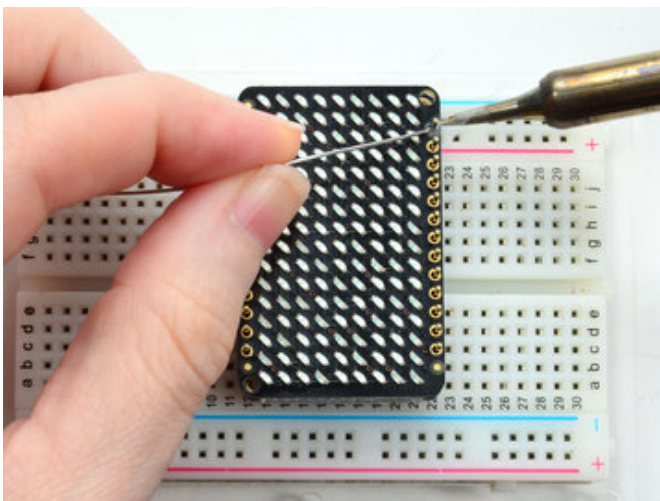
Attach LED panel

Now we'll sandwich on the charlieplexed LED panel

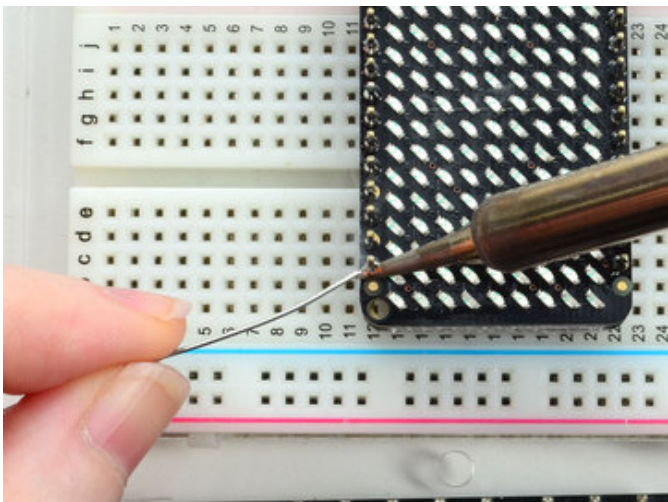
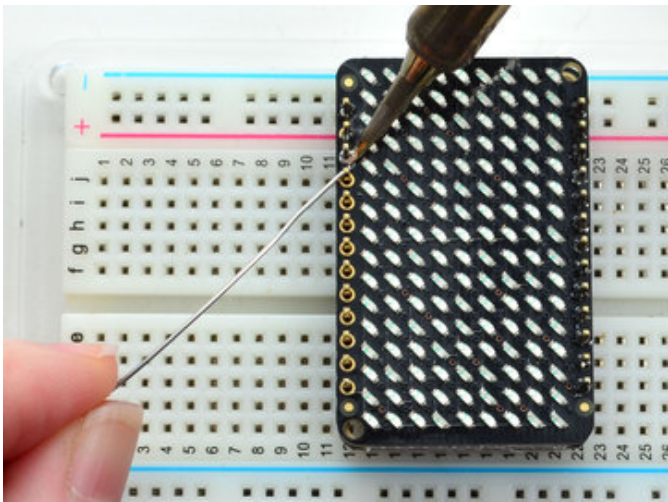
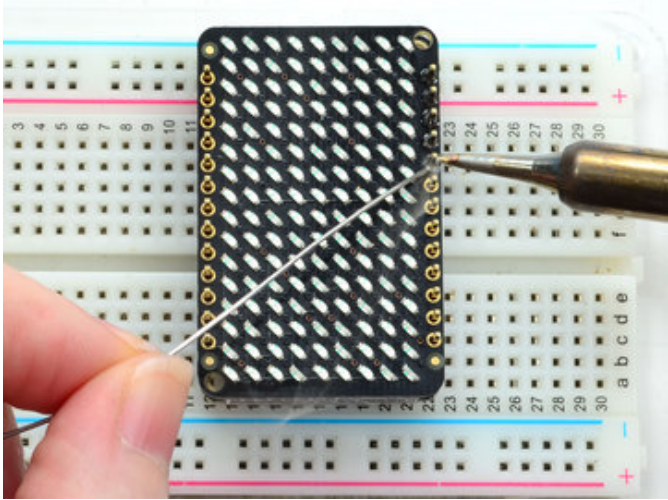


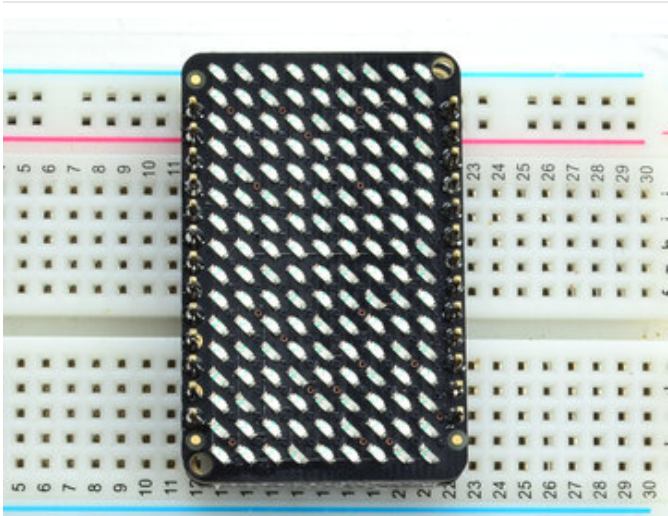
The LEDs face out and connect to the two side header strips.

The panel is **symmetric** - you can flip it around either way and it will work fine

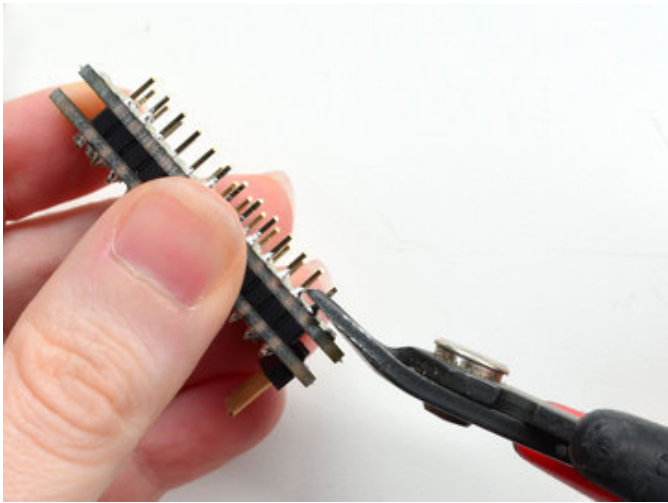


Solder in the two long header strips. Not all are connected on the LED matrix but it makes the connections mechanically stable.



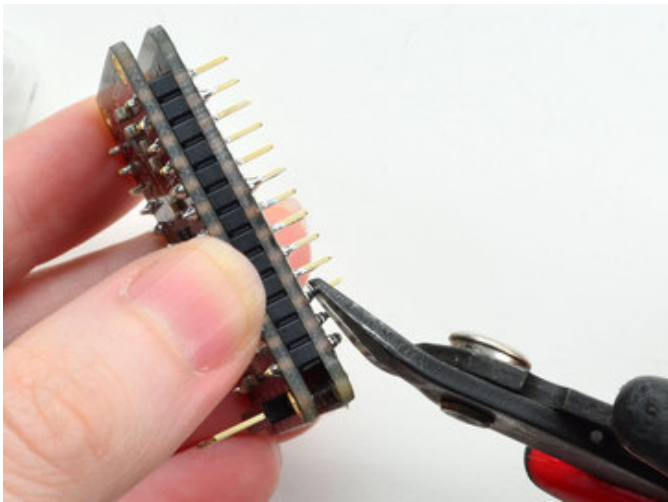


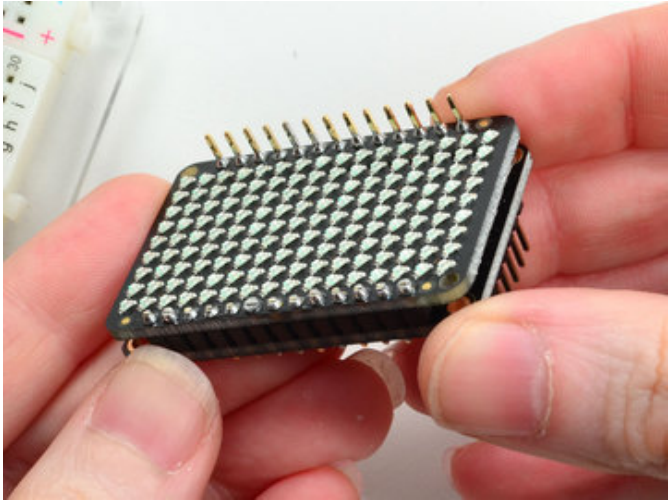
Check your solder joints visually and continue onto the next steps



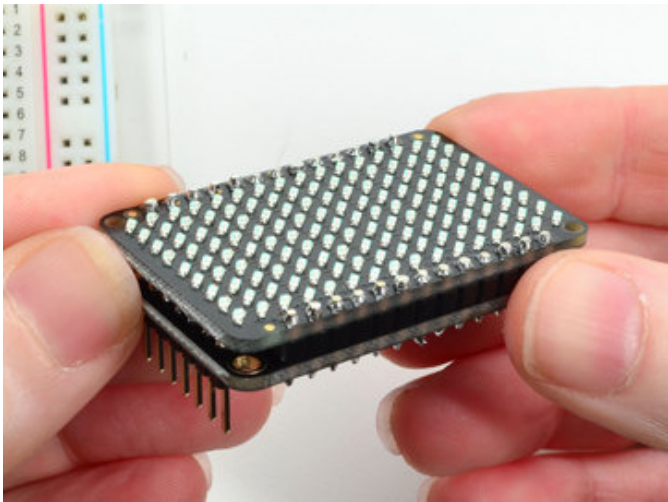
Now you can trim the long header with diagonal cutters.
Cut one or two pins at a time

**Watch out for flying header bits. Wear eye protection
and be careful!**



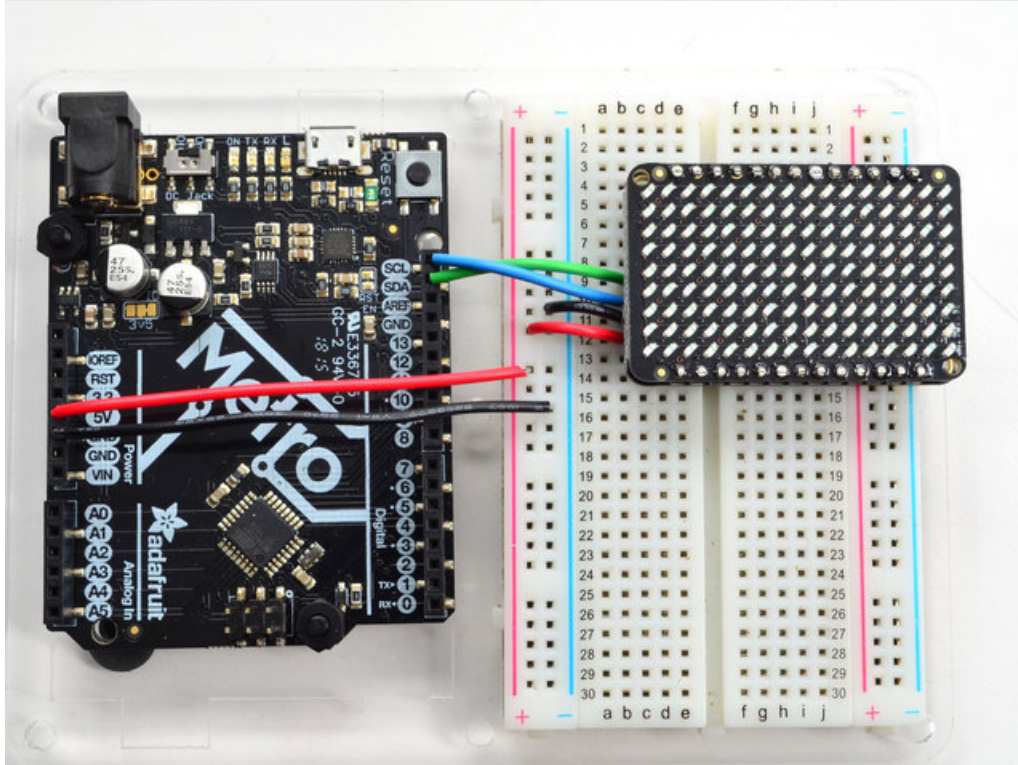


Cut both sides down for the best look



You're done! Check your solder joints visually and continue onto the next steps

Arduino Wiring & Test



You can easily wire this breakout to any microcontroller, we'll be using an Arduino. For another kind of microcontroller, as long as you have I2C pins available, just check out the library, then port the code.

Wiring

Use this wiring if you want to connect via I2C interface

- Connect **Vin** to the power supply, 3-5V is fine. Use the same voltage that the microcontroller logic is based off of. For most Arduinos, that is 5V
- Connect **GND** to common power/data ground
- Connect the **SCL** pin to the I2C clock **SCL** pin on your Arduino. On an UNO & '328 based Arduino, this is also known as **A5**, on a Mega it is also known as **digital 21** and on a Leonardo/Micro, **digital 3**
- Connect the **SDA** pin to the I2C data **SDA** pin on your Arduino. On an UNO & '328 based Arduino, this is also known as **A4**, on a Mega it is also known as **digital 20** and on a Leonardo/Micro, **digital 2**

Download Adafruit_IS31FL3731 library

To begin reading sensor data, you will need to [download Adafruit_IS31FL3731 from our github repository](#). You can do that by visiting the github repo and manually downloading or, easier, just click this button to download the zip

Download the Adafruit_IS31FL3731 Library

<https://adafru.it/IWB>

Rename the uncompressed folder **Adafruit_IS31FL3731** and check that the **Adafruit_IS31FL3731** folder contains **Adafruit_IS31FL3731.cpp** and **Adafruit_IS31FL3731.h**

Place the **Adafruit_IS31FL3731** library folder your **arduinoketchfolder/libraries/** folder.

You may need to create the **libraries** subfolder if its your first library. Restart the IDE.

We also have a great tutorial on Arduino library installation at:
<http://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use>

Install Adafruit GFX

You will need to do the same for the `Adafruit_GFX` library available [here](#)

Download Adafruit_GFX Library

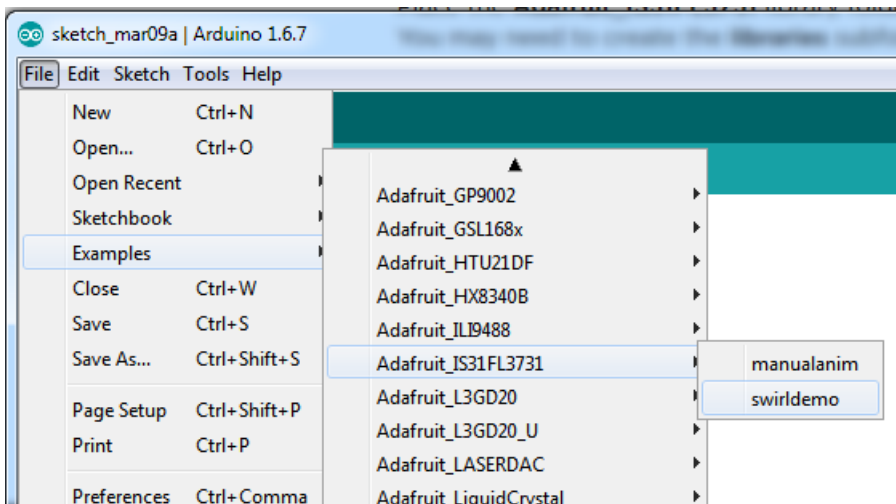
<https://adafru.it/cBB>

Rename the uncompressed folder `Adafruit_GFX` and check that the `Adafruit_GFX` folder contains `Adafruit_GFX.cpp` and `Adafruit_GFX.h`

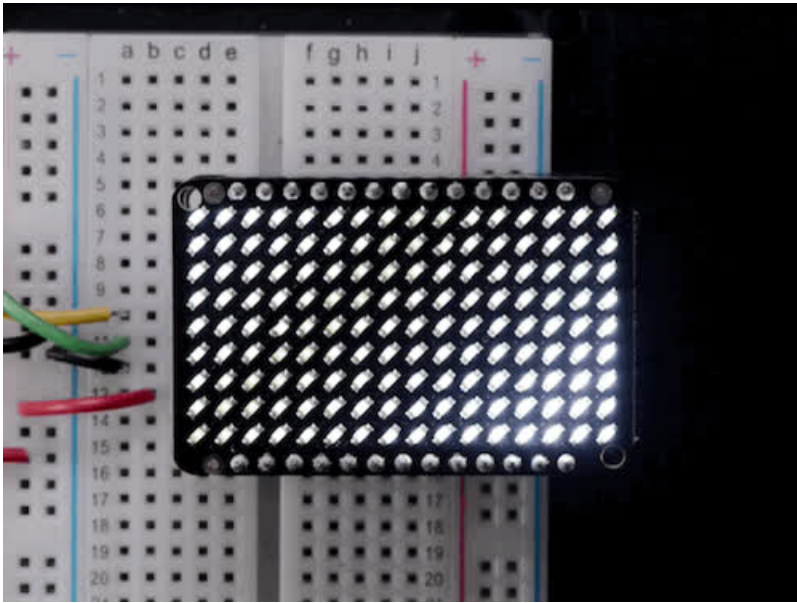
Place the `Adafruit_GFX` library folder your `arduinorsketchfolder/libraries/` folder like you did with the IS31FL library

Load Demo

Open up `File->Examples->Adafruit_IS31FL3731->swirldemo` and upload to your Arduino wired up to the driver & matrix



Upload to your Arduino, you'll see the LED display swirl different brightnesses!



Library Reference

Now that you have the demo working, you can control the matrix directly.

Initialize

Start by creating a new matrix object with something like:

```
Adafruit_IS31FL3731 ledmatrix = Adafruit_IS31FL3731();
```

There's no arguments to the constructor

Then in your setup, call **begin(address)** to initialize the driver. Begin() will return false if the matrix was not found, and true if initialization worked out

```
if (! ledmatrix.begin()) {  
  Serial.println("IS31 not found");  
  while (1);  
}  
Serial.println("IS31 found!");
```

Drawing

You can then draw to the display. Note that since we write directly to the driver RAM, any pixels 'drawn' will appear immediately.

You can start with **drawPixel(x, y, brightness)** where x ranges between 0 and 15 inclusive, and y ranges between 0 and 8 inclusive. **Brightness** is the PWM of the LED, 0 is off, and 255 is all the way on.

This loop will light up every LED in increasing brightness:

```
int i = 0;  
for (uint8_t x=0; x<16; x++) {  
  for (uint8_t y=0; y<9; y++) {  
    ledmatrix.drawPixel(x, y, i++);  
  }  
}
```

Adafruit GFX

Once you get pixels drawing, you can use Adafruit GFX to draw lines, rectangles, circles, text, etc.

The Adafruit_GFX library for Arduino provides a common syntax and set of graphics functions for all of our LED, TFT, LCD and OLED displays. This allows Arduino sketches to easily be adapted between display types with minimal fuss... and any new features, performance improvements and bug fixes will immediately apply across our complete offering of color displays.

Check out our detailed tutorial here <http://learn.adafruit.com/adafruit-gfx-graphics-library> It covers the latest and greatest of the GFX library!

Multiple Buffers

The IS31 has 8 full display frame buffers available. By default you draw and display to frame buffer #0

But! If you want to flip thru different images quickly, you can double buffer by writing to one buffer and then telling the IS31 to switch which one is visible.

To set which frame we are **drawing** to, use **setFrame(*n*)**
where *n* ranges from 0 to 7 inclusive

```
ledmatrix.setFrame(frame);
```

Then when you are ready to display it, to set which frame we are **displaying** to, use **displayFrame(*n*)**
where *n* ranges from 0 to 7 inclusive

```
ledmatrix.displayFrame(frame);
```

CircuitPython

Adafruit CircuitPython Module Install

To use the Charlieplex display with your [Adafruit CircuitPython](#) board you'll need to install the [Adafruit_CircuitPython_IS31FL3731](#) module on your board. **Remember this module is for Adafruit CircuitPython firmware and not MicroPython.org firmware!**

First make sure you are running the [latest version of Adafruit CircuitPython](#) for your board. Next you'll need to install the necessary libraries to use the hardware--read below and carefully follow the referenced steps to find and install these libraries from [Adafruit's CircuitPython library bundle](#).

Bundle Install

For express boards that have extra flash storage, like the Feather/Metro M0 express and Circuit Playground express, you can easily install the necessary libraries with [Adafruit's CircuitPython bundle](#). This is an all-in-one package that includes the necessary libraries to use the IS31FL3731 Charlieplex driver with CircuitPython. To install the bundle follow the steps in your board's guide, like [these steps for the Feather M0 express board](#).

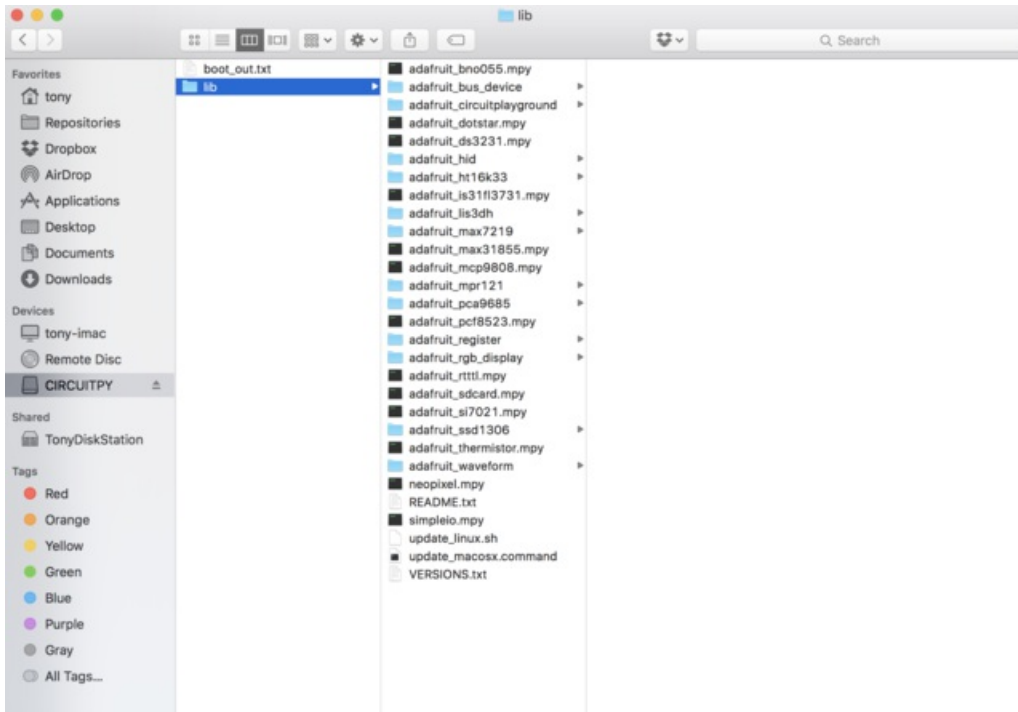
Remember for non-express boards like the Trinket M0, Gemma M0, and Feather/Metro M0 basic you'll need to manually install the necessary libraries from the bundle:

- `adafruit_is31fl3731.mpy`

If your board supports USB mass storage, like the M0-based boards, then simply drag the files to the board's file system. **Note on boards without external SPI flash, like a Feather M0 or Trinket/Gemma M0, you might run into issues on Mac OSX with hidden files taking up too much space when drag and drop copying, [see this page for a workaround](#).**

If your board doesn't support USB mass storage, like the ESP8266, then [use a tool like ampy to copy the file to the board](#). You can use the latest version of ampy and its [new directory copy command](#) to easily move module directories to the board.

Before continuing make sure your board's lib folder or root filesystem has the `adafruit_is31fl3731.mpy` module copied over.



Usage

The following section will show how to control the Charlieplex display from the board's Python prompt / REPL. You'll learn how to interactively control the display, turn on/off LEDs, control brightness and more by typing in the code below.

First [connect to the board's serial REPL](#) so you are at the CircuitPython >>> prompt.

I2C Initialization

First you'll need to initialize the I2C bus for your board. First import the necessary modules:

```
import board
import busio as io
```

Note if you're using the ESP8266 or other boards which do not support hardware I2C you need to import from the bitbangio module instead of busio:

```
import board
import bitbangio as io
```

Now for either board run this command to create the I2C instance using the default SCL and SDA pins (which will be marked on the boards pins if using a Feather or similar Adafruit board):

```
i2c = io.I2C(board.SCL, board.SDA)
```

Charlieplex Usage

Once I2C is initialized you're ready to import and use the Charlieplex module. First import the **adafruit_is31fl3731**

module by running:

```
import adafruit_is31fl3731
```

Next depending on what display you're using you can create an instance of a Charlieplex display class:

- **Matrix** - This class represents the 16 x 9 LED grid matrix used by the Charlieplex driver breakout.
- **CharlieWing** - This class represents the 15 x 7 LED Charlieplex FeatherWing.

For example to use the CharlieWing you can run:

```
display = adafruit_is31fl3731.CharlieWing(i2c)
```

Note that you need to pass the I2C bus created above into the initializer for the class.

Alternatively you can use the Charlieplex driver & matrix breakout by running:

```
display = adafruit_is31fl3731.Matrix(i2c)
```

If you've changed the I2C address of the Charlieplex driver you can specify it with an optional **address** keyword parameter too. For example if the driver has an I2C address of 0x77 you can run:

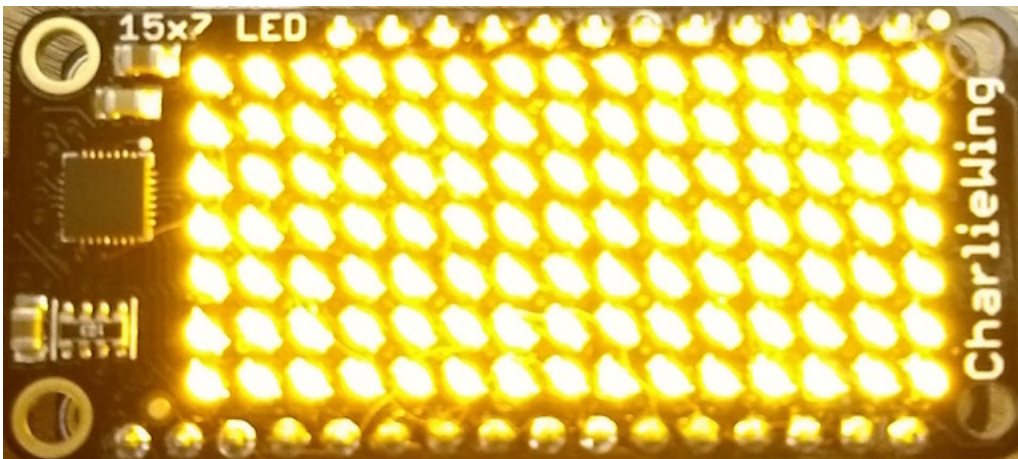
```
display = adafruit_is31fl3731.Matrix(i2c, address=0x77)
```

The address parameter can be used with the CharlieWing class too.

When the display initializes it will go through and clear each frame (there are 8 frames total) of the display. You might see the display momentarily flash and then turn off to a clear no pixel lit image.

You can control all of the board's pixels using the fill function. Send to this function a value from 0 to 255 where 0 is every LED pixel turned off and 255 is every LED pixel turned on to maximum brightness. For example to set all the pixels to half their brightness run:

```
display.fill(127)
```

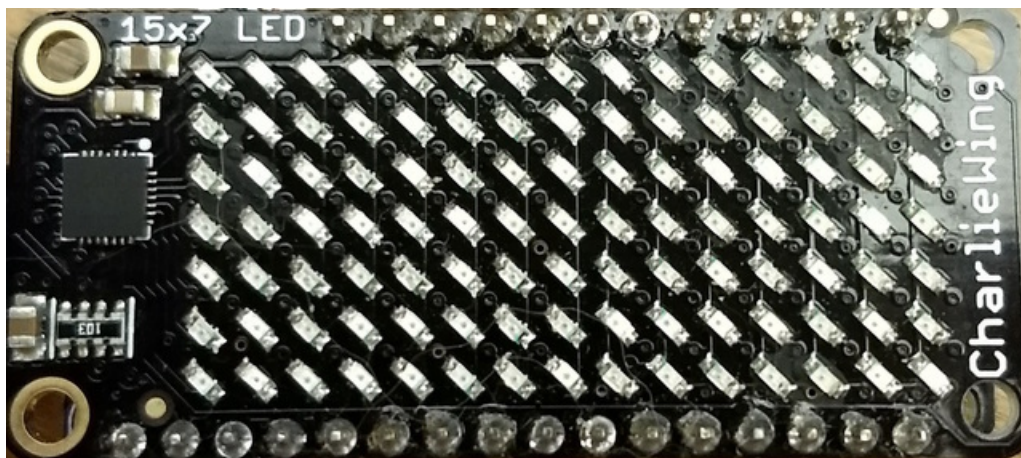


You might notice some buzzing or ringing sounds from the display when all pixels are lit, this is normal as the Charlieplex driver quickly switches LEDs on and off.

If you've used other displays like LED matrices you might notice the Charlieplex module doesn't need to have a show function called to make the changes visible. As soon as you call fill or other display functions the display will update!

You can turn all the pixels off by filling them with color 0:

```
display.fill(0)
```



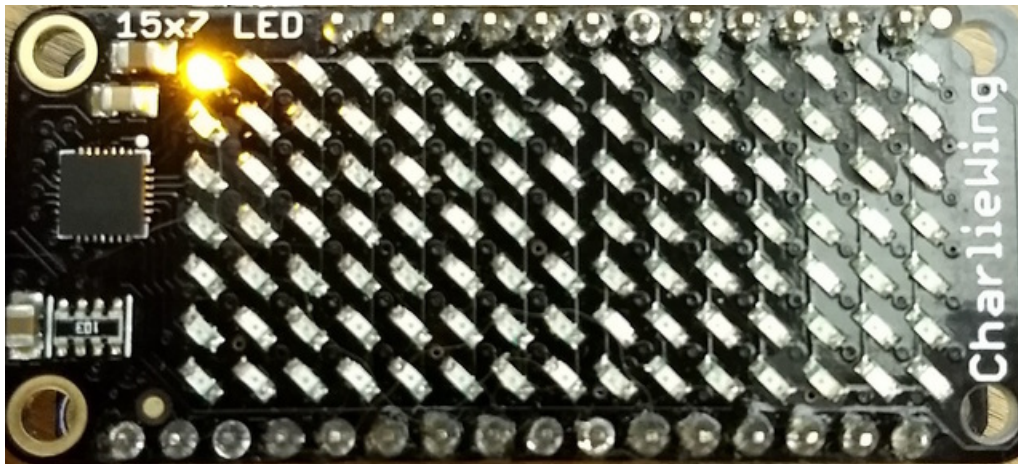
Be careful setting all pixels to 255 maximum brightness! This might pull more power than your computer's USB port can provide if you are powering your board over USB. Use an external powers supply or battery when lighting lots of LEDs to max brightness.

Now for some fun! You can set any of the LED pixels using the `pixel` function. This function takes the following parameters:

- **X position** - The location of the horizontal / X pixel position.
- **Y position** - The location of the vertical / Y pixel position.
- **Intensity** - This is a value from 0 to 255 which specifies how bright the pixel should be, 0 is off and 255 is maximum brightness. Use an in-between value to show a less bright pixel.

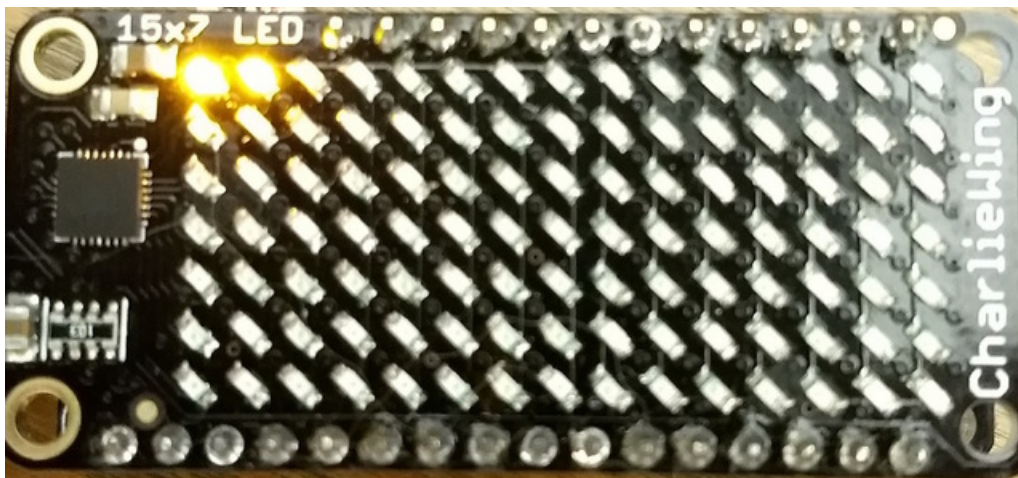
For example to set pixel 0, 0 to full brightness run:

```
display.pixel(0, 0, 255)
```



Or to set the pixel next to it horizontally to half brightness run:

```
display.pixel(1, 0, 127)
```



You can turn off individual pixels by setting them to an intensity of zero.

You can even make pixels blink! The board supports a fixed blink rate that you set using the blink function. This function takes in the number of milliseconds to use for the blink rate (but internally it can only blink in 270ms increments so you might not get an exact match). For example to blink pixels about once every half second call:

```
display.blink(500)
```

You'll notice nothing actually changes on the board. This is because in addition to intensity each LED pixel has a blink state which can be enabled and disabled. The fill command can actually set all pixels and turn them on to blink:

```
display.fill(127, blink=True)
```

You can turn off the blinking by setting blink=False.

The pixel command supports the blink parameter too! You can turn on and off blinking pixel by pixel as needed. For example to turn on blinking for pixel 0, 0:

```
display.pixel(0, 0, 127, blink=True)
```

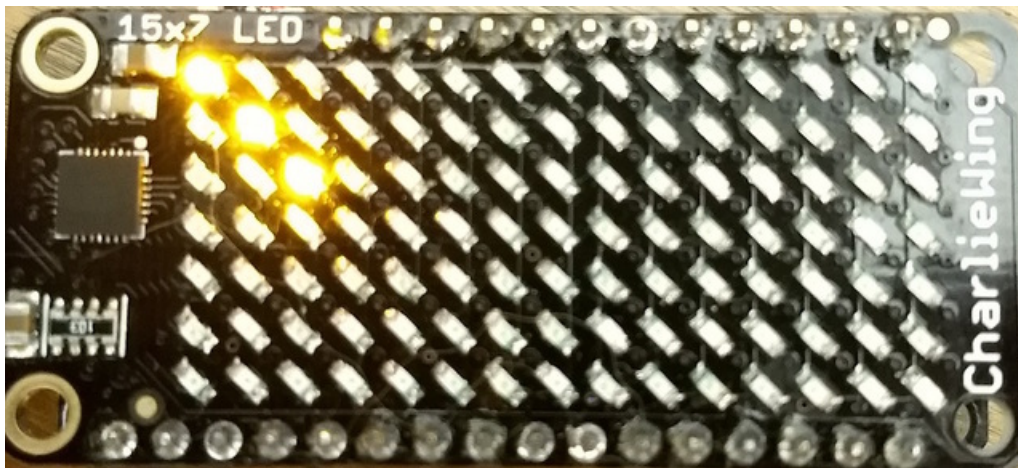
Currently the Charlieplex module is very simple and only exposes pixel set commands. In the future more advanced graphics commands like line drawing, text display, etc. might be implemented but for now you'll need to manipulate the pixels yourself.

Finally the display supports holding up to 8 frames of pixel data. Each frame contains an entire matrix of LED pixel state (intensity, blinking, etc.) and by default the module starts you on frame 0. You can change to start displaying and drawing on another frame by calling `frame` which takes these parameters:

- **Frame number** - This is the frame number to make the active frame for display or drawing. There are 8 frames total, 0 through 7.
- **Show** - An optional boolean that defaults to True and specifies if the frame should be immediately displayed (True) or just made active so that pixel and fill commands draw on it but it's not yet shown.

For example to clear frame 1 and draw a few pixels on it, then display it you can run:

```
display.frame(1, show=False)
display.fill(0)
display.pixel(0, 0, 255)
display.pixel(1, 1, 255)
display.pixel(2, 2, 255)
display.frame(1) # show=True is the default, the frame will be displayed!
```



Notice how the first call switches to make frame 1 the active frame but doesn't display it because `show` is set to false. Then the frame pixel data is changed with `fill` and `pixel` commands, and finally the frame is shown by calling `frame` again but letting the default `show = True` be used so the frame is displayed.

Using frames you can build simple animations by drawing each frame and swapping between them over time!

That's all there is to the basic Charlieplex driver module usage! Be sure to [see the module documentation](#) for more details on advanced usage.

Full Example

Here's a complete example that randomly turns on LEDs for the Charlieplex FeatherWing. This is good to review all

the steps of setting up the display and drawing pixels. You can read the comments to learn more about the random number generation functions in CircuitPython and MicroPython's random module too. Save this file as a `main.py` on your board's root file system and watch it randomly turn on LEDs to different intensity values.

```
# Charlieplex FeatherWing random pixel drawing demo.
# Author: Tony DiCola
# License: Public Domain

# Import necessary libraries:
import board
# If using an M0 board with hardware I2C use this line:
import busio as io
# If using the ESP8266 with software I2C use this line instead:
#import bitbangio as io
import random
import time

import adafruit_is31fl3731

# Initialize I2C bus:
i2c = io.I2C(board.SCL, board.SDA)

# Create the FeatherWing display:
display = adafruit_is31fl3731.CharlieWing(i2c)

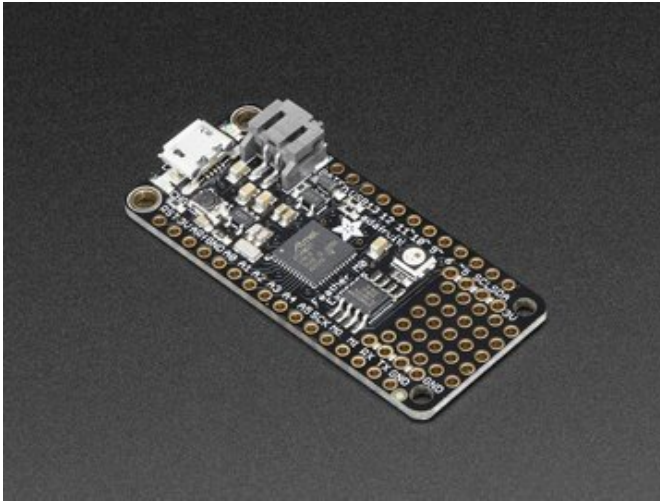
# Turn off all the pixels.
display.fill(0)

# Main loop forever turning on/off random pixels and delaying for random amounts
# of time.
while True:
    # Generate random X, Y coordinates within the FeatherWing display bounds.
    x = random.randrange(0, 16) # randrange generates a random number within
    y = random.randrange(0, 8) # the first parameter and up to but not
    # including the second parameter.

    # Generate a random intensity within the range of 0 to 192:
    intensity = random.randrange(0, 193)
    # Set the pixel.
    display.pixel(x, y, intensity)
    # Delay for a random small period of time. The uniform function
    # generates a floating point value (i.e. fractional) within the specified
    # range (inclusive for first parameter, exclusive for second).
    # Sleep for a short ~10 to 100 millisecond period of time.
    time.sleep(random.uniform(0.01, 0.1))
```

Wiring Parts

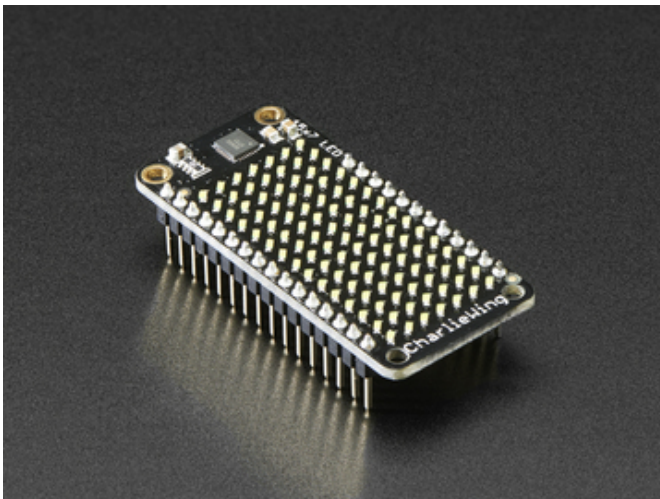
You'll need the following parts to follow this guide:



CircuitPython board. This guide focuses on the [ESP8266 \(https://adafru.it/n6A\)](https://adafru.it/n6A) and [Feather M0/SAMD21-based boards \(http://adafru.it/2772\)](http://adafru.it/2772), but any CircuitPython board that supports I2C should work.

If your board doesn't come with CircuitPython running on it already then check out your board's guide for how to load CircuitPython firmware. For example the [Feather M0 express guide \(https://adafru.it/wbv\)](https://adafru.it/wbv) is a good reference.

If you're using a Feather board and FeatherWing you probably want a [Feather female header set \(http://adafru.it/2886\)](http://adafru.it/2886) or [Feather stacking female header set \(http://adafru.it/2830\)](http://adafru.it/2830).



CharliePlex Matrix & Driver or FeatherWing. If you're using a Feather the [CharliePlex FeatherWing \(http://adafru.it/2965\)](http://adafru.it/2965) is the perfect option that easily connects to the Feather. For other boards you'll need a [CharliePlex driver \(http://adafru.it/2946\)](http://adafru.it/2946) and [matrix \(https://adafru.it/sch\)](https://adafru.it/sch) (they are separate components that must be connected together).



Breadboard (<http://adafru.it/64>) and **jumper wires** (<http://adafru.it/153>). If you aren't using a Feather and FeatherWing you'll need a breadboard and jumper wires to connect the components.

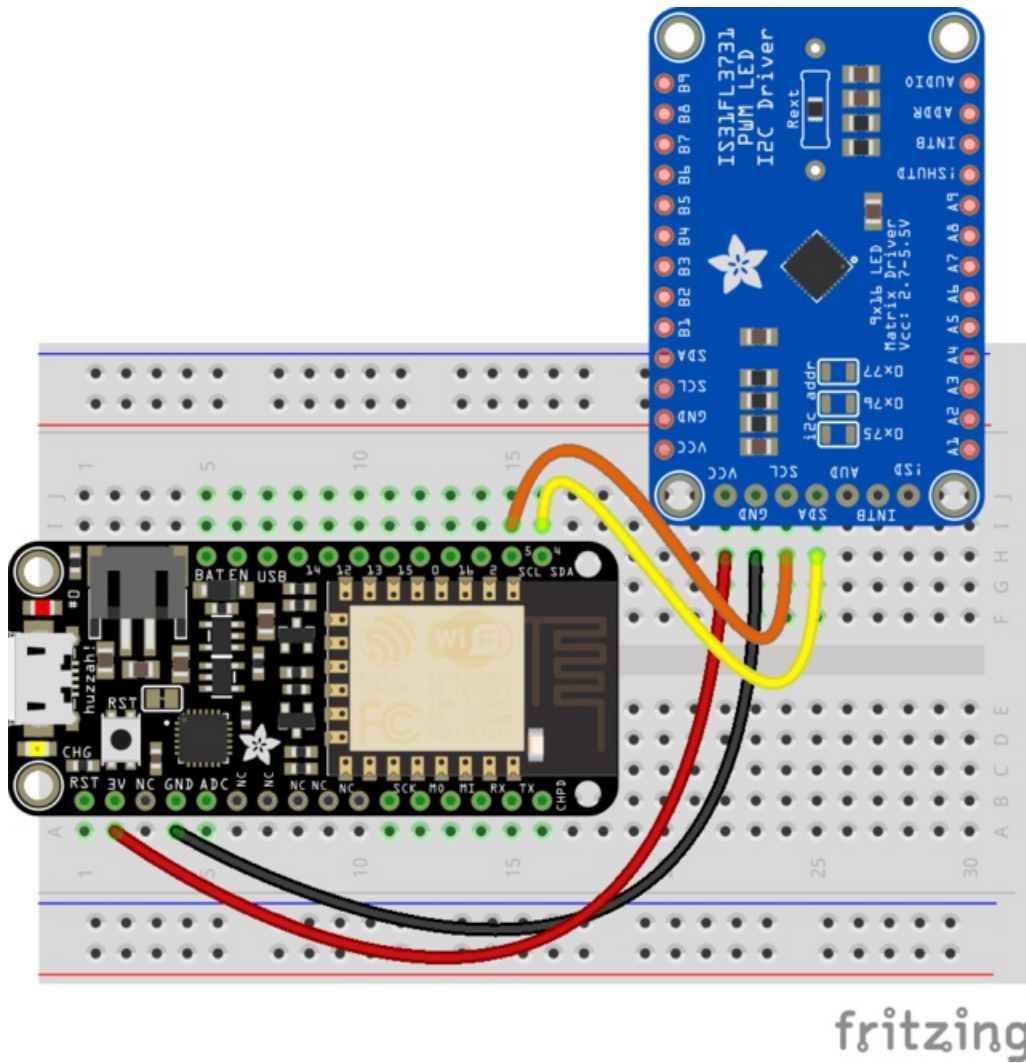
Soldering tools (<http://adafru.it/136>). You'll need to solder headers to the boards. Check out the [guide to excellent soldering](https://adafru.it/dxy) (<https://adafru.it/dxy>) if you're new to soldering.

Make sure to follow the board and Charlieplex [FeatherWing](#) or [driver](#) product guides to assemble and verify they work before continuing.

Wiring

If you're using a FeatherWing and Feather just slide the wing onto the Feather board and you're all set! The FeatherWing will automatically be connected to the board using its I2C connection. Skip to the next page to learn about the software to control the display.

If you're using a Charlieplex breakout you'll need to connect its power, ground, and I2C connections to the board. For example the wiring for a Charlieplex driver to Feather HUZAZH ESP8266 might look like:



Fritzing Source

<https://adafru.it/zID>

- Board SCL / I2C clock to Charlieplex Driver SCL.
- Board SDA / I2C data to Charlieplex Driver SDA.
- Board 3.3V power to Charlieplex Driver VCC.
- Board GND / ground to Charlieplex Driver GND.

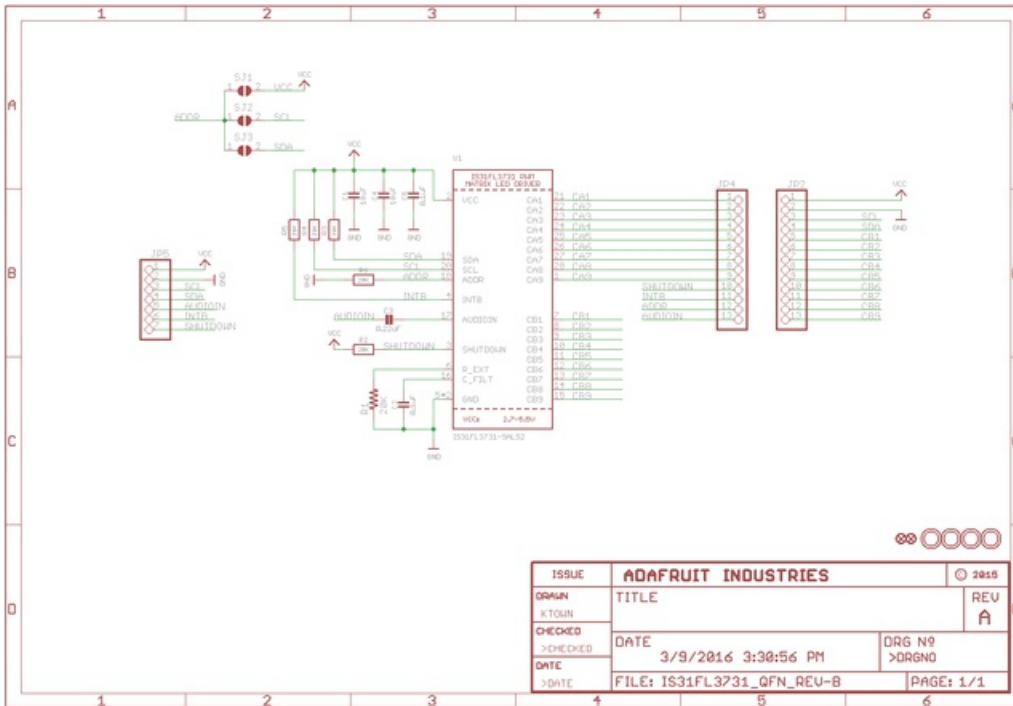
Downloads

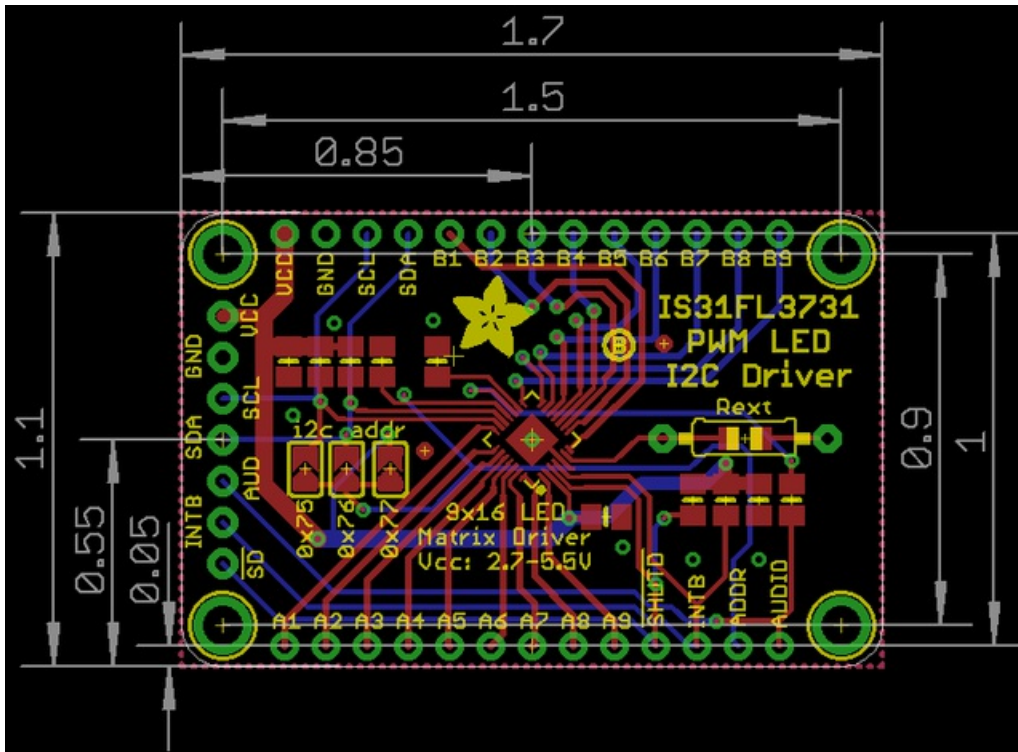
Datasheets & Files

- [EagleCAD PCB files on GitHub](#)
- [Fritzing objects in the Adafruit Fritzing library](#)
- [IS31FL3731 Datasheet](#)

IS31FL3731 Breakout

Schematics & Fabrication Print (Dimensions in Inches)





16x9 0603 LED Grid

Schematics & Fabrication print (dimensions in inches)

