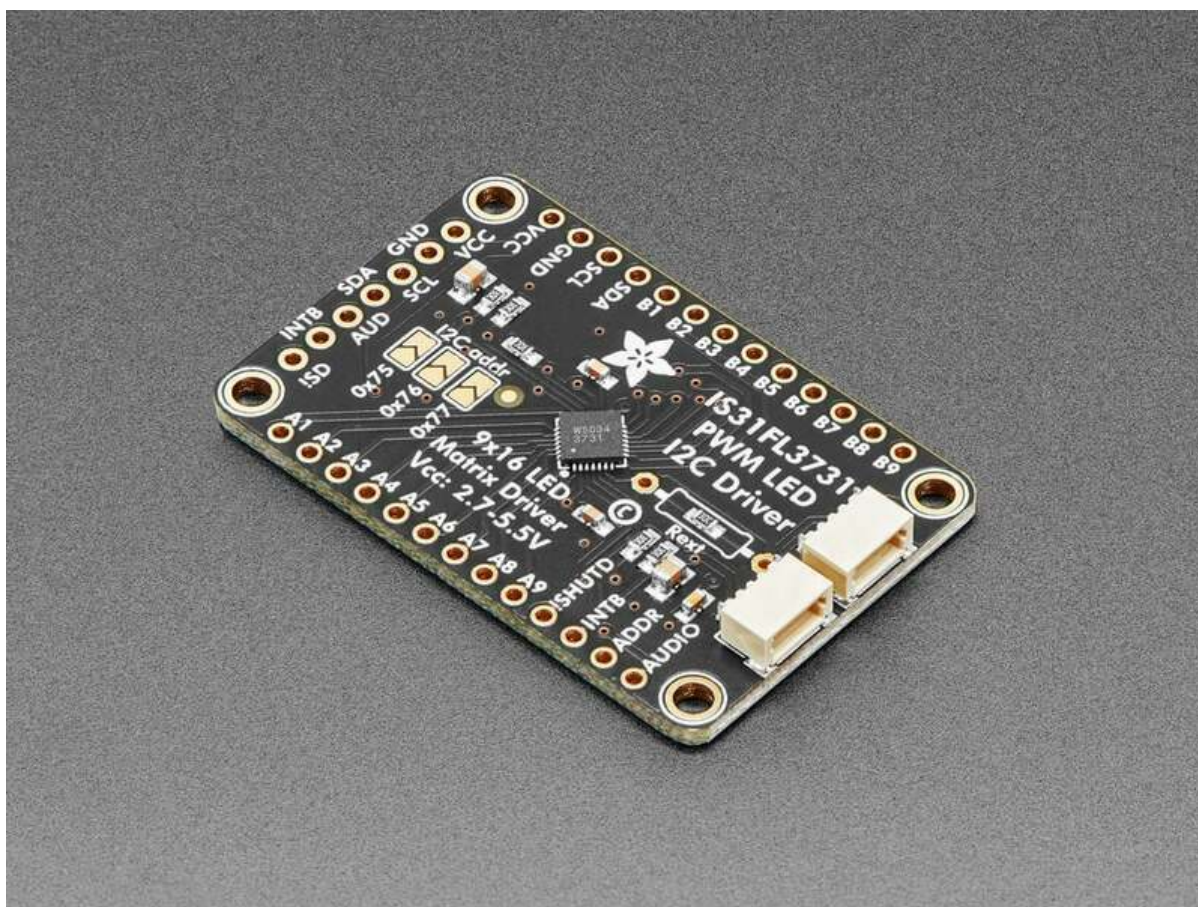




IS31FL3731 16x9 Charlieplexed PWM LED Driver

Created by lady ada



<https://learn.adafruit.com/i31fl3731-16x9-charlieplexed-pwm-led-driver>

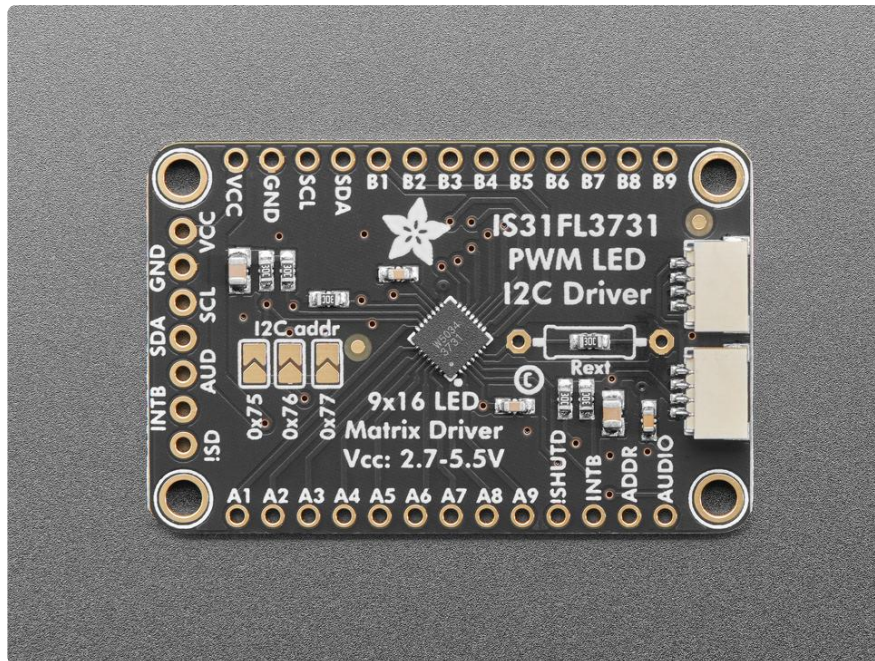
Last updated on 2024-03-08 02:24:23 PM EST

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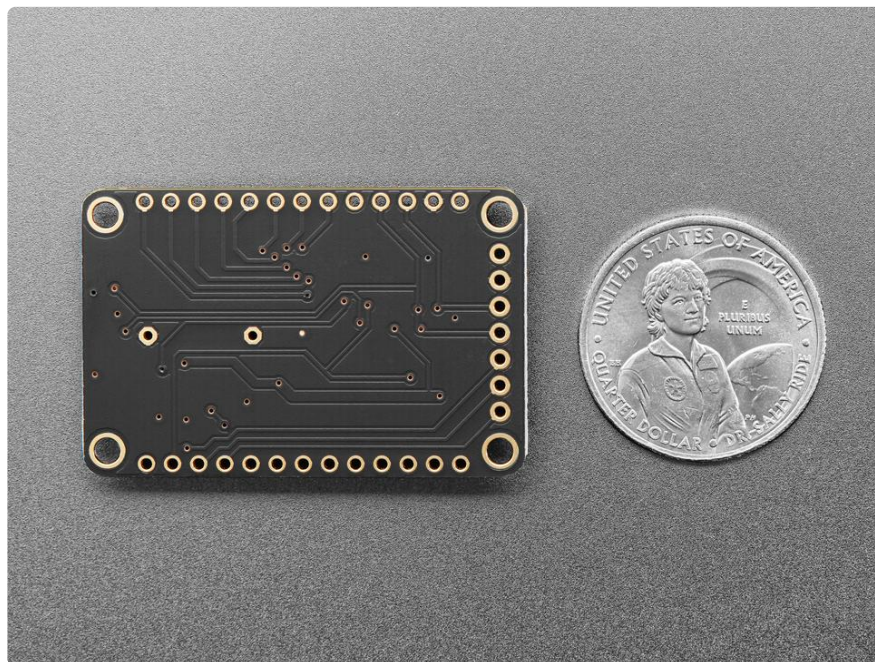
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-
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Overview

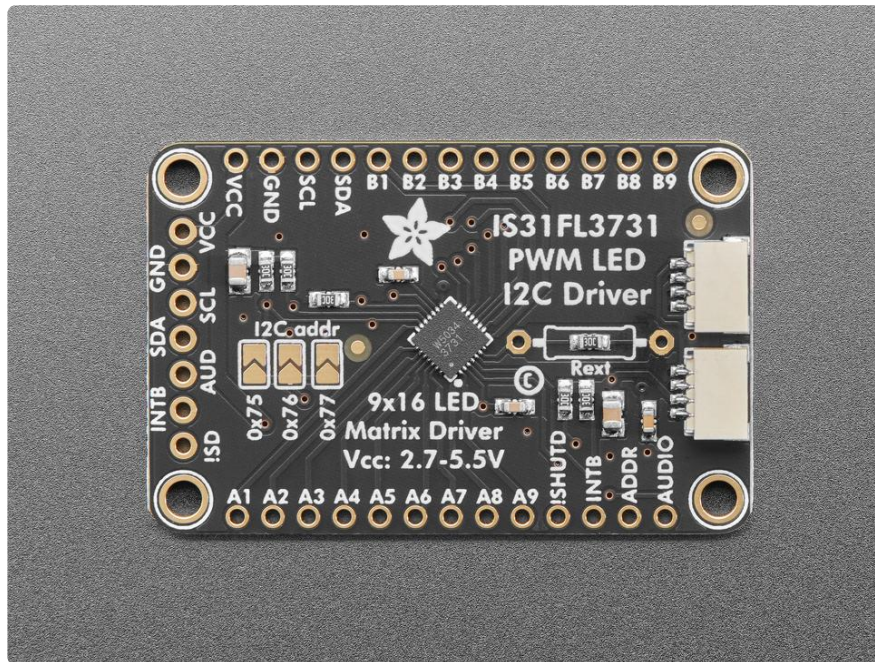


The IS31FL3731 will let you get back to that classic LED matrix look, with a nice upgrade! This I2C LED driver chip has the ability to PWM each individual LED in a **16x9 grid** so you can have beautiful LED lighting effects, without a lot of pin twiddling. Simply tell the chip which LED on the grid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

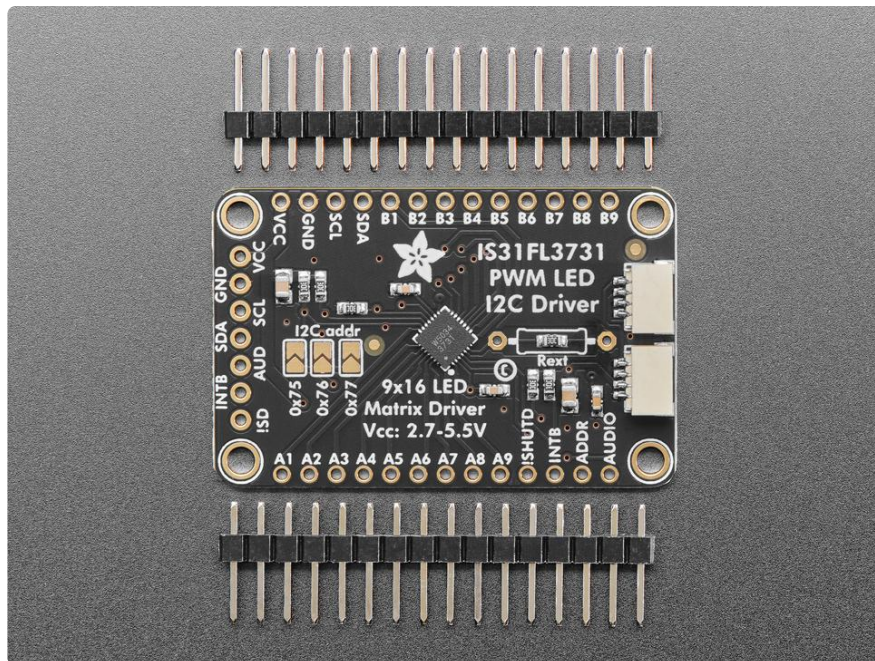


The IS31FL3731 is a nice little chip - it can use 2.7-5.5V power and logic so it's flexible for use with any microcontroller. You can set the address so up to 4 matrices can share an I2C bus. Inside is enough RAM for 8 separate frames of display memory, so

you can set up multiple frames of an animation and flip them to be displayed with a single command.



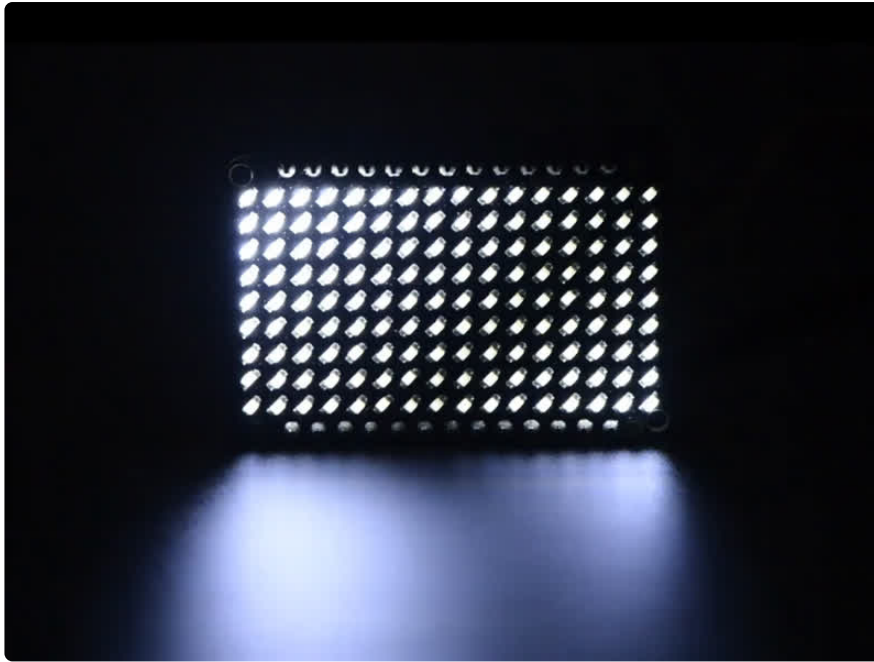
This chip is great for making small LED displays, and we even designed the breakout to match up with our ready-to-go LED grids in red, yellow, green, blue and white. Sandwich the driver and matrix breakout, solder together for a compact setup. Or you can DIY your own setup, just follow the LED grid schematic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



To get you going fast, we spun up a custom-made PCB in the [STEMMA QT form factor](https://adafruit.it/LBQ) (<https://adafruit.it/LBQ>), making it easy to interface with. The [STEMMA QT connectors](https://adafruit.it/JqB) (<https://adafruit.it/JqB>) are compatible with the [SparkFun Qwiic](https://adafruit.it/JqB) ([https://](https://adafruit.it/JqB)

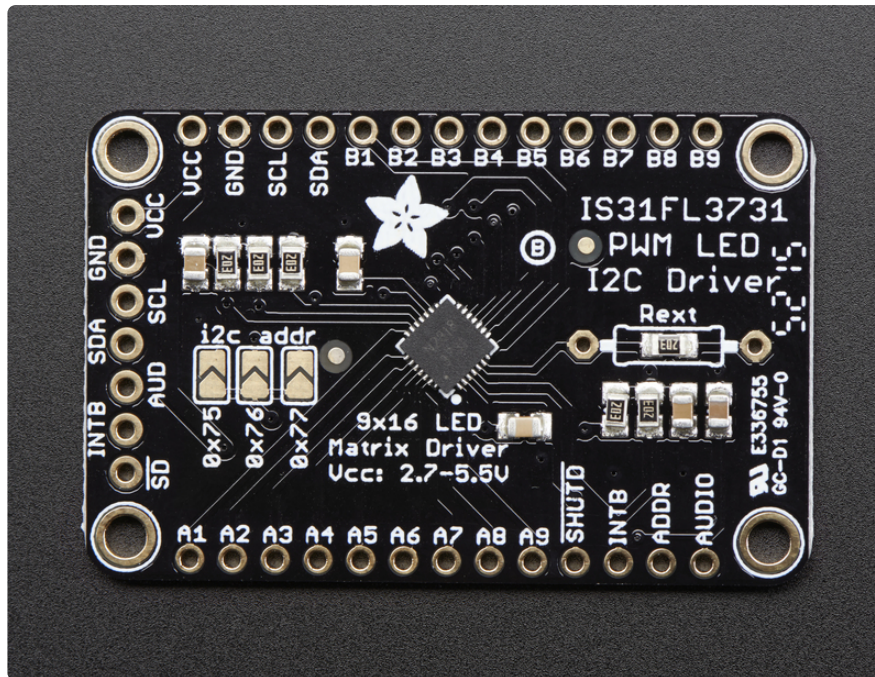
adafru.it/Fpw) I2C connectors. This allows you to make solderless connections between your development board and the IS31FL3731 or to chain it with a wide range of other sensors and accessories using a [compatible cable](https://adafru.it/JnB) (<https://adafru.it/JnB>). The IS31 is compatible with 3-5V power and logic, so it's ready to go with just about any microcontroller or microcomputer board!

Please note this does not come with any LEDs, you can pick up a matching LED matrix from us or DIY / do your own.

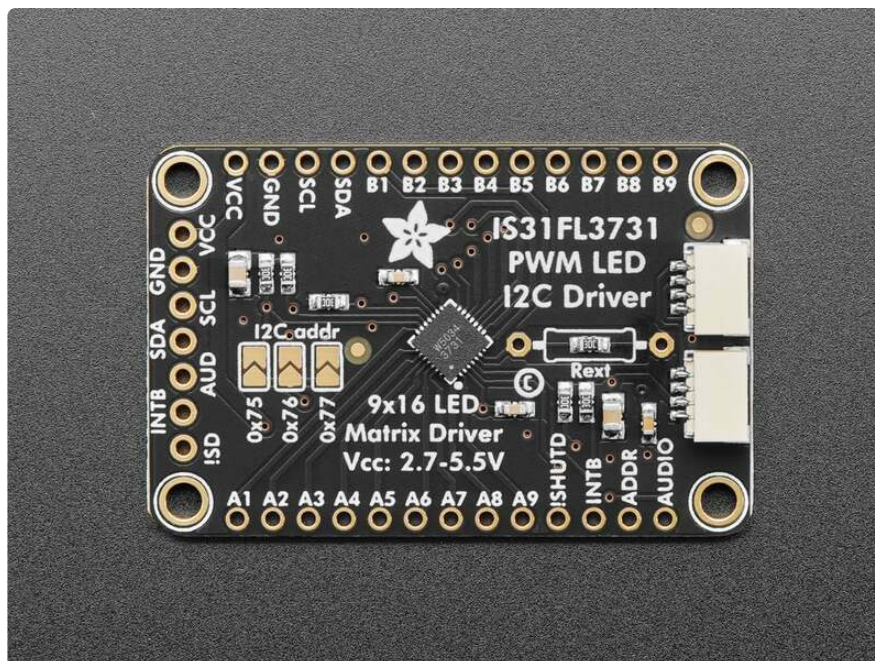


Pick up a driver board and your favorite color LEDs to match. You'll need to do some basic soldering to attach the driver backpack and matrix together, and run wires to your microcontroller, but its not too hard. Then install our Arduino or CircuitPython libraries to get some LEDs blinking immediately.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

There are two versions of this board - the STEMMA QT version shown above, and the original header-only version shown below. Code works the same on both!



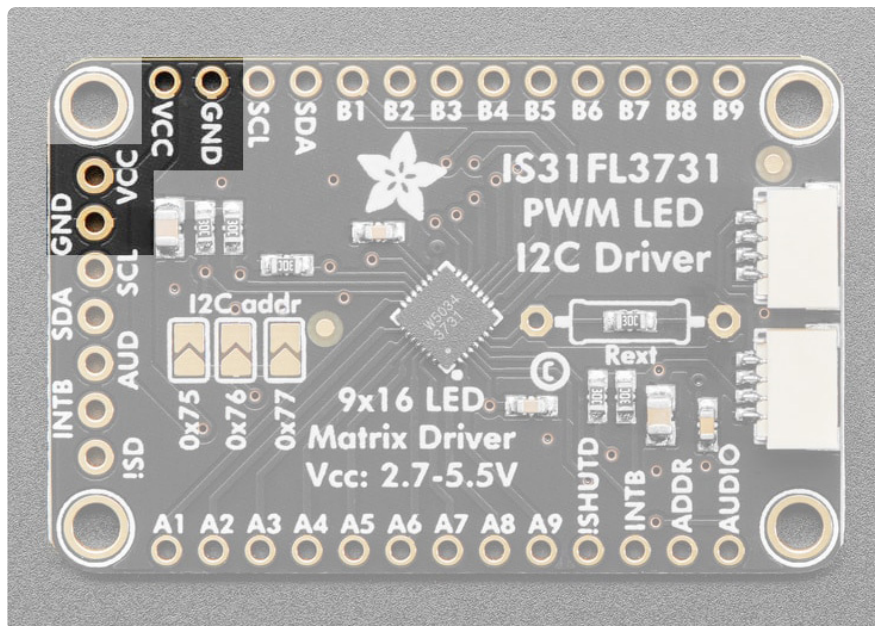
Pinouts



The default I2C address is **0x74**.

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

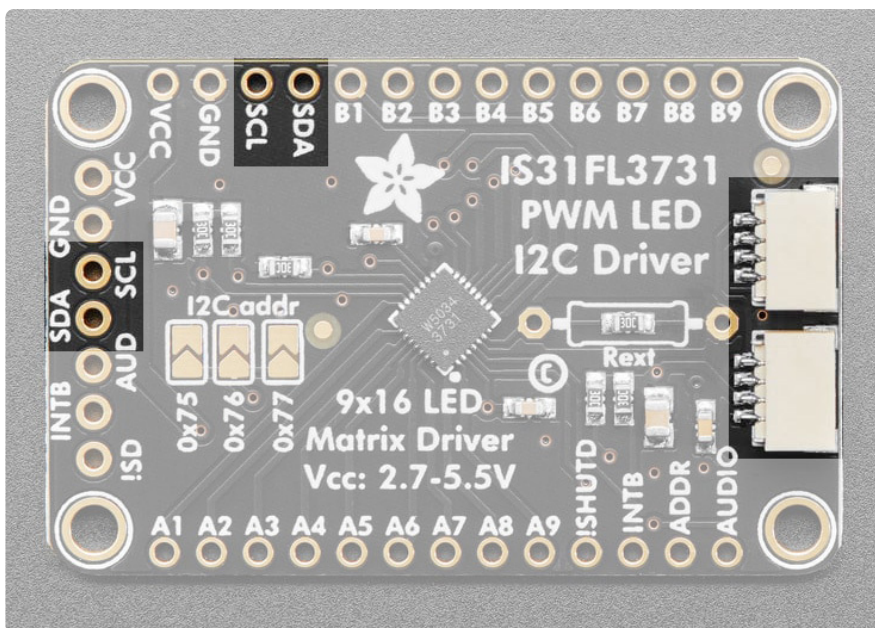


You can power the IS31 from 2.7-5.5VDC, but note that the same voltage is used for both power and logic.

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.

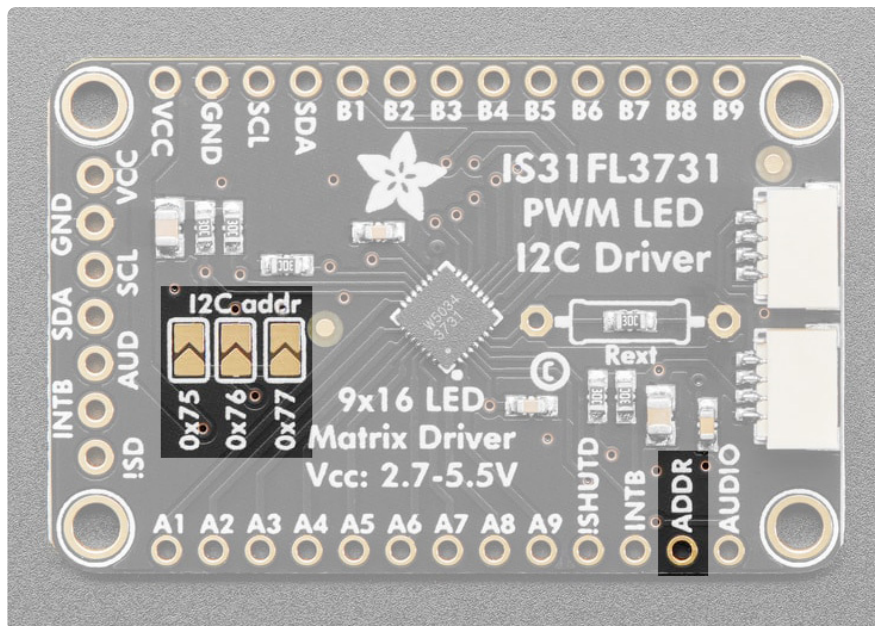
I2C Data Pins



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.
- **STEMMA QT** (<https://adafru.it/Ft4>) (on the STEMMA QT version only) - These connectors allow you to connect to development boards with **STEMMA QT** connectors, or to other things, with [various associated accessories](https://adafru.it/Ft6) (<https://adafru.it/Ft6>).

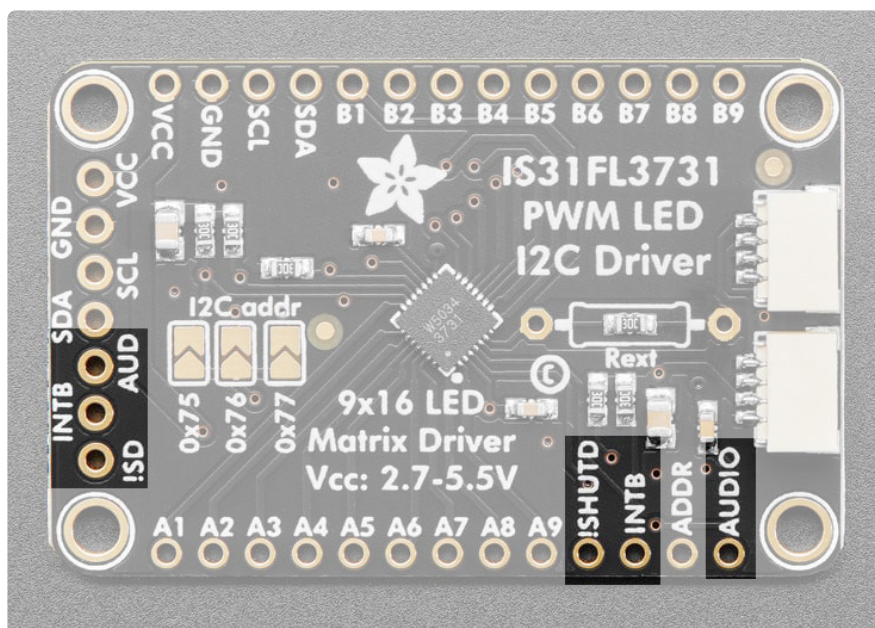
Address Jumpers and Address Pin



- **Address Jumpers (0x75, 0x76, 0x77)** - There are three address jumpers on the board, labeled **0x75**, **0x76** and **0x77**, below the **I2C addr** label on the board silk. This jumpers allows you to chain up to 4 of these boards on the same pair of I2C clock and data pins. To do so, you solder the jumper "closed" by connecting the two pads. The default I2C address is **0x74**. To select a new address, solder the jumper labeled with the desired address closed. For example, to set the I2C address to **0x76**, solder the **0x76** jumper.
- **ADDR** - I2C address selection pin. The IS31FL3731 has a base 7-bit I2C address of **0x74** (1110100) and a clever addressing scheme that allows four different addresses using just one address pin (named **ADDR** for **ADDR**ess). To program the address, connect the address pin as follows:

I2C ADDR	ADDR Pin
0x74	GND
0x75	SCL
0x76	SDA
0x77	VCC

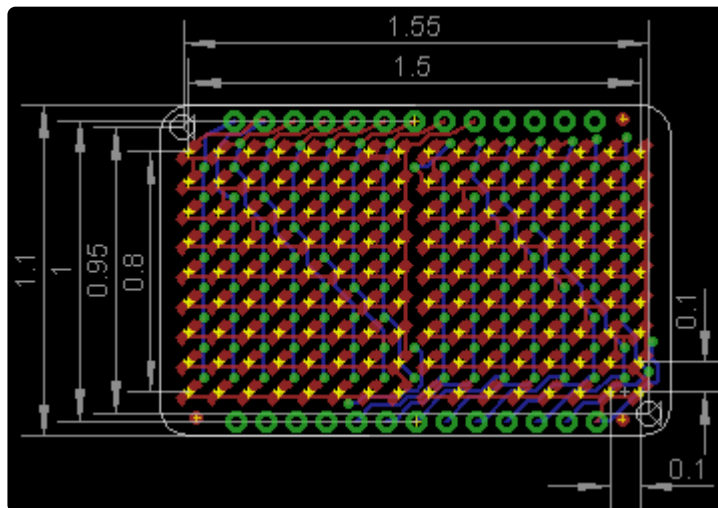
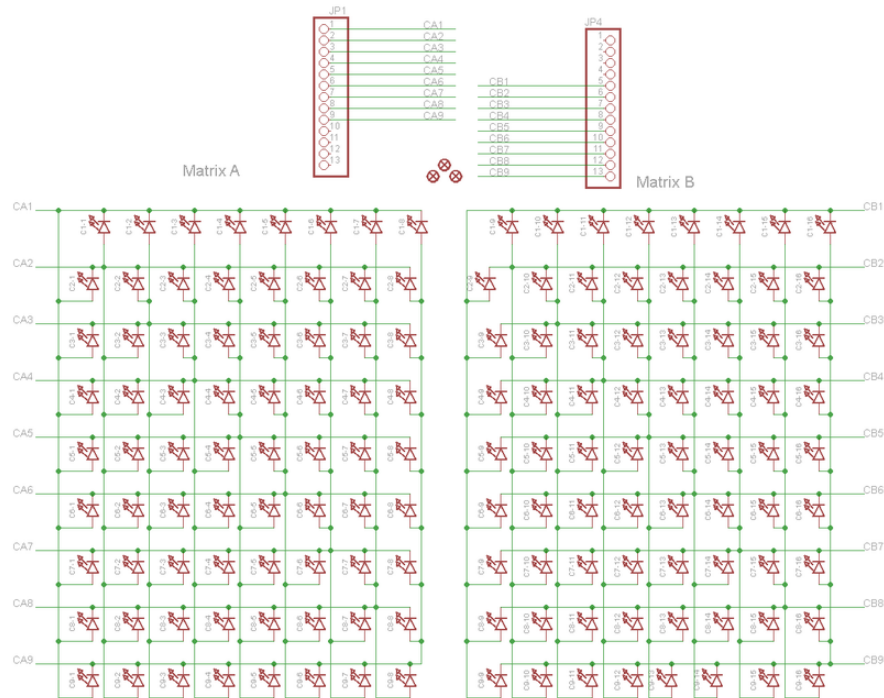
Other Control Pins



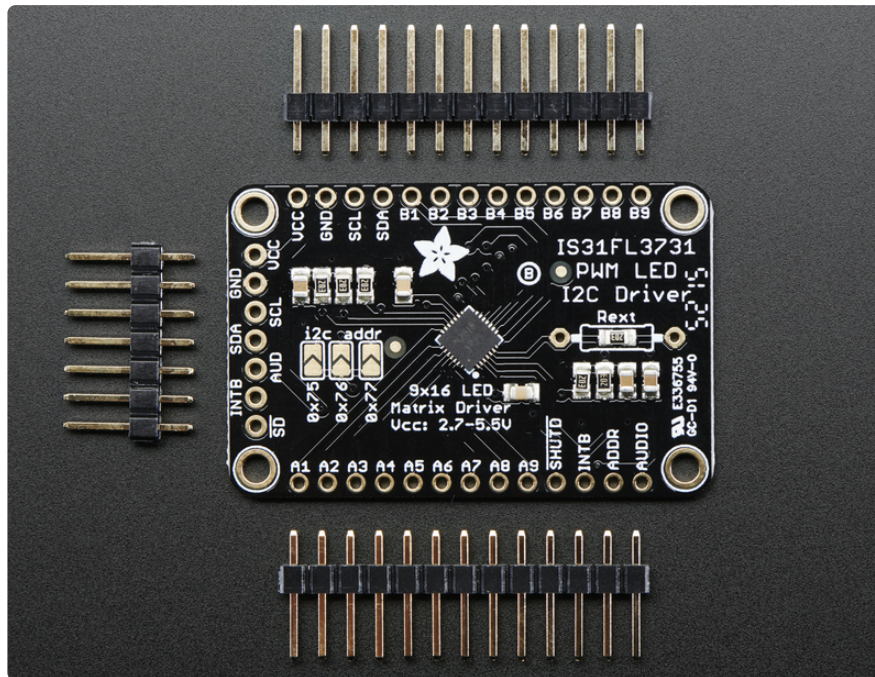
- **!SD** or **!SHUTD** - Shutdown pin, default pulled up to VCC. Connect to ground to put the chip in shutdown mode.
- **AUD** or **AUDIO** - Audio input, can be used to modulate the entire display with the amplitude of a line level audio signal. It has a series capacitor installed.
- **INTB** - Output 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

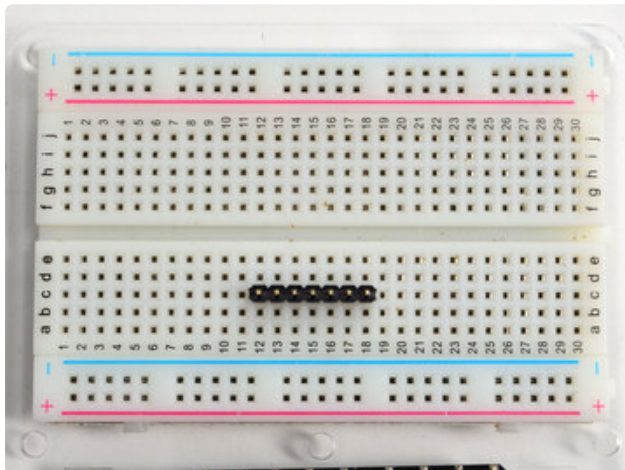


Assembly



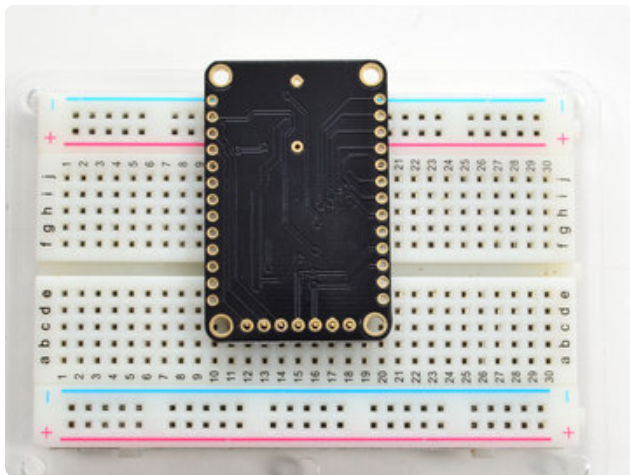
Assemble the IS31 Driver Board

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.



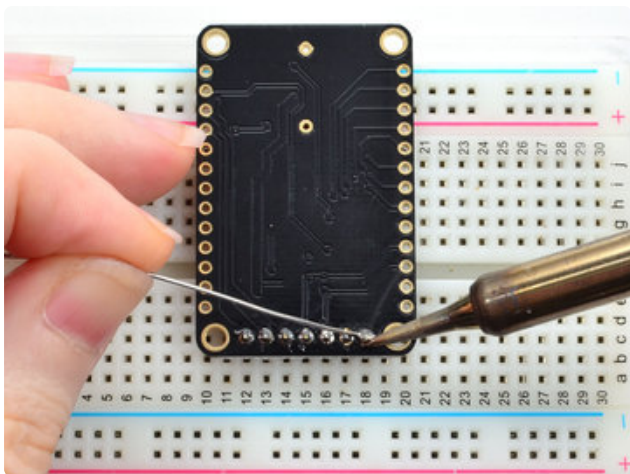
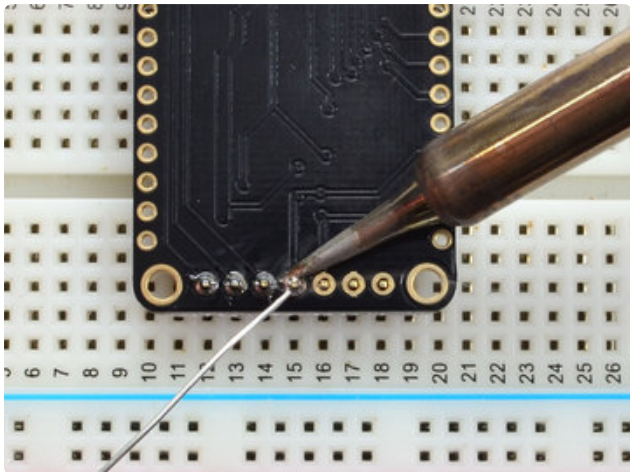
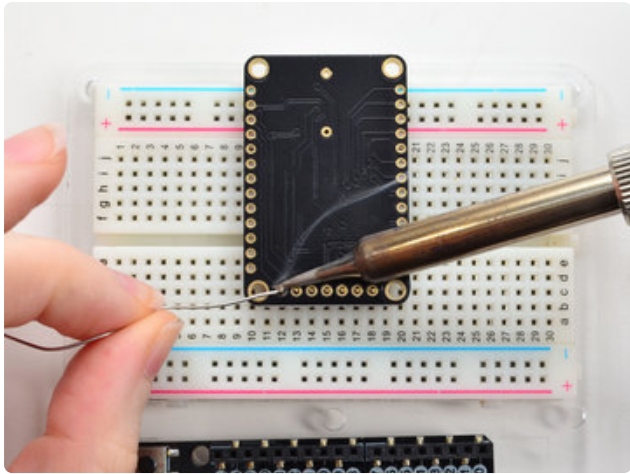
Prepare the header strip:

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:

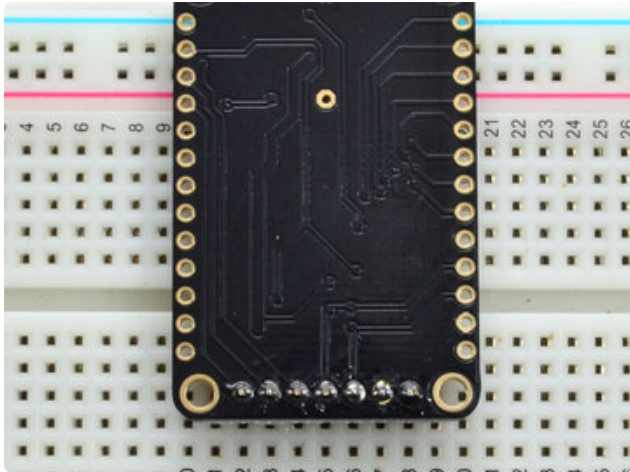
Place the breakout board over the pins so that the short pins poke through the breakout pads



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)).

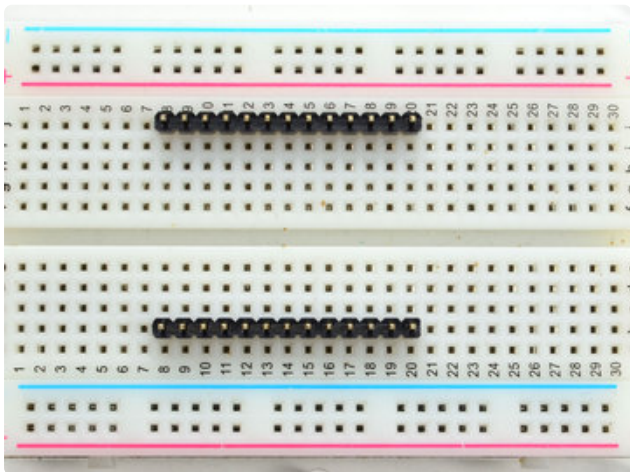


OK the control port header is done.

Check your solder joints visually and continue onto the next steps

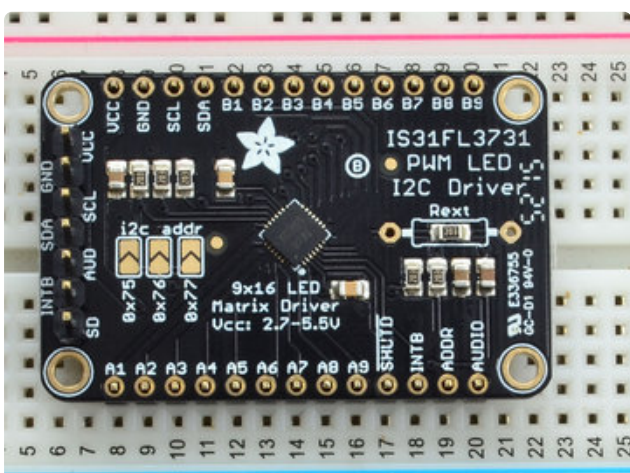
Solder Driver Headers for LEDs

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



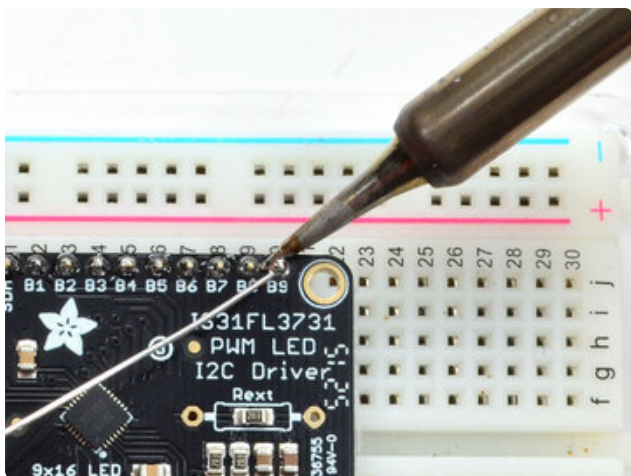
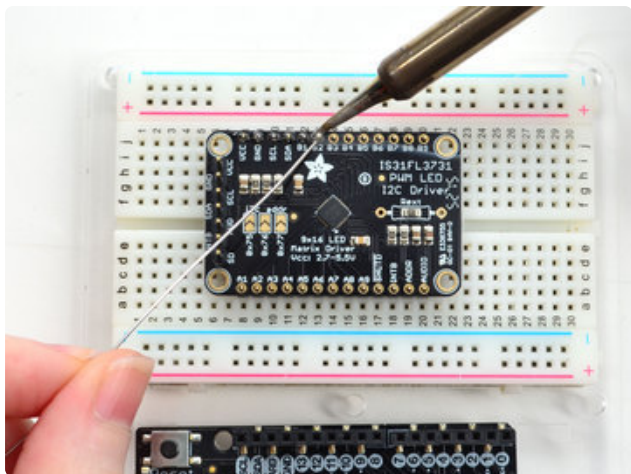
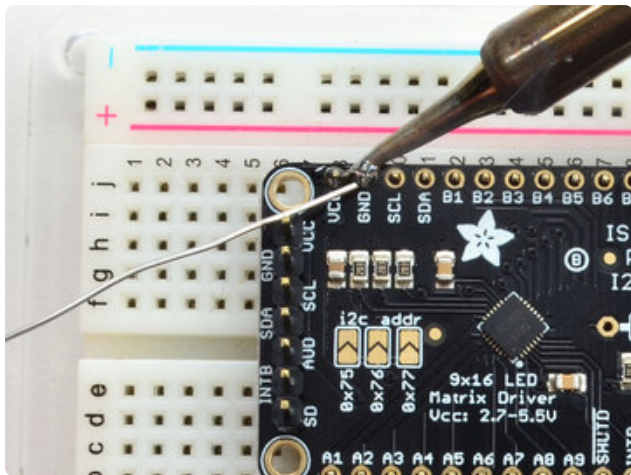
Prepare the header strip:

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:

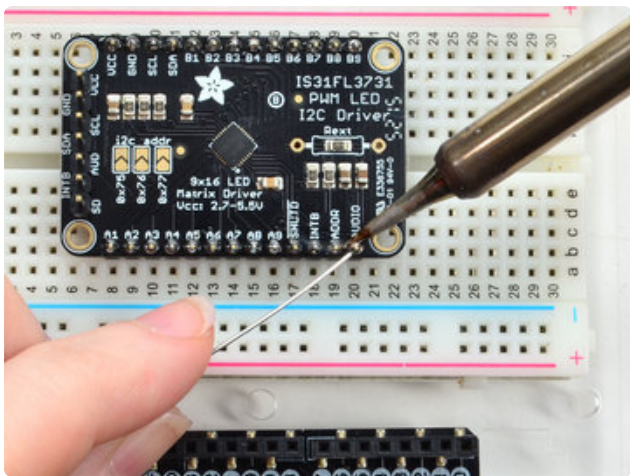
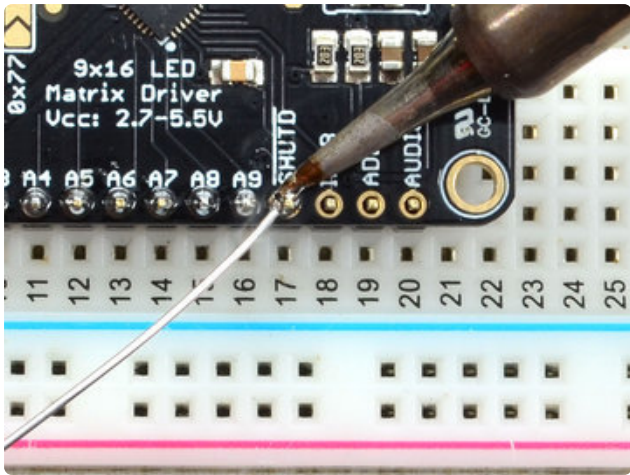
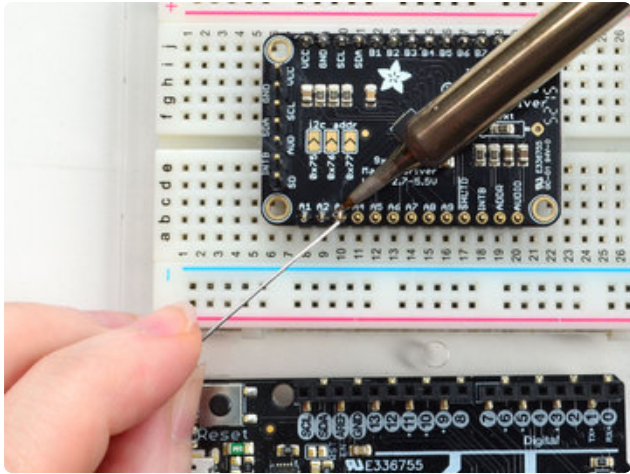
Place the breakout board over the pins so that the short pins poke through the breakout pads

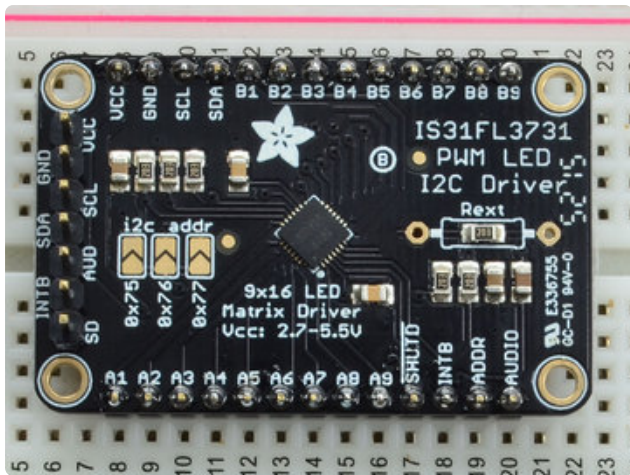


And Solder!

Be sure to solder all pins for reliable electrical contact.

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



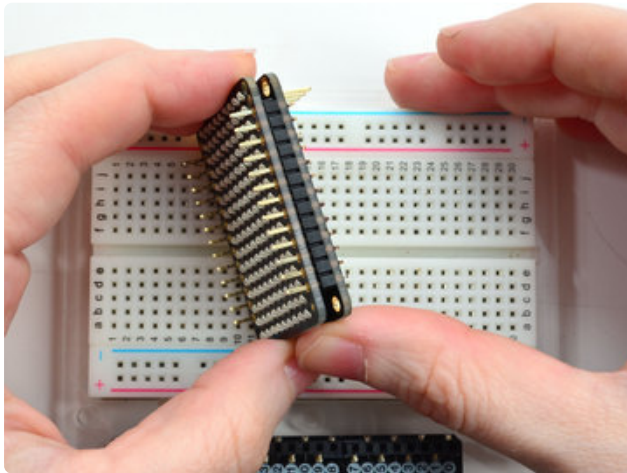


OK now you have the control and LED pads with headers.

Check your solder joints visually and continue onto the next steps

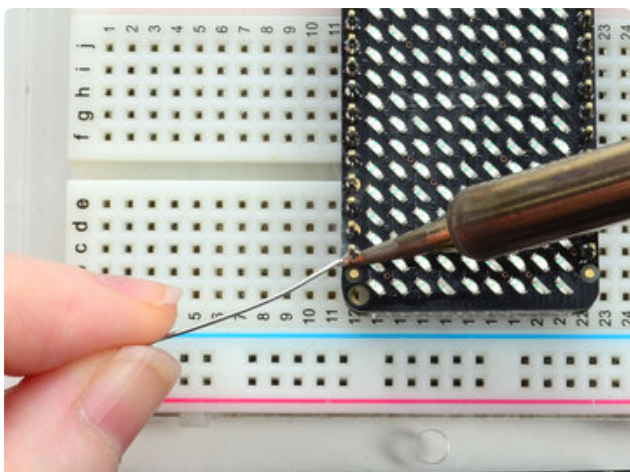
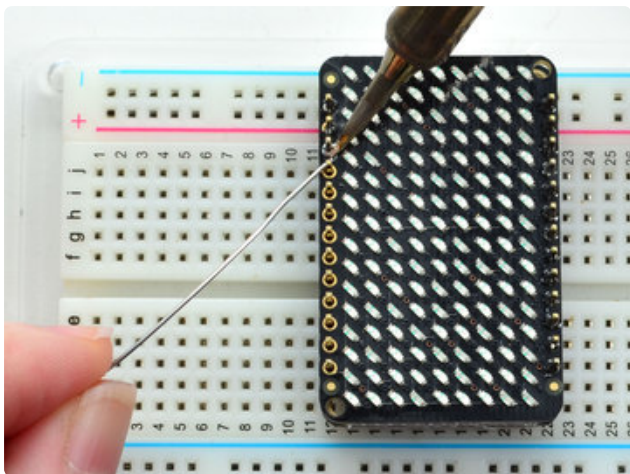
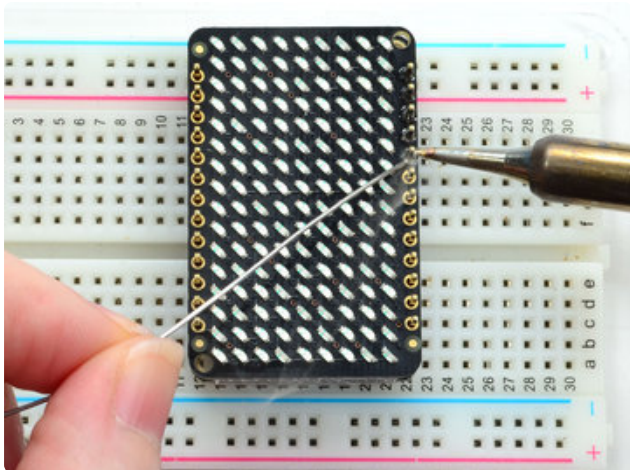
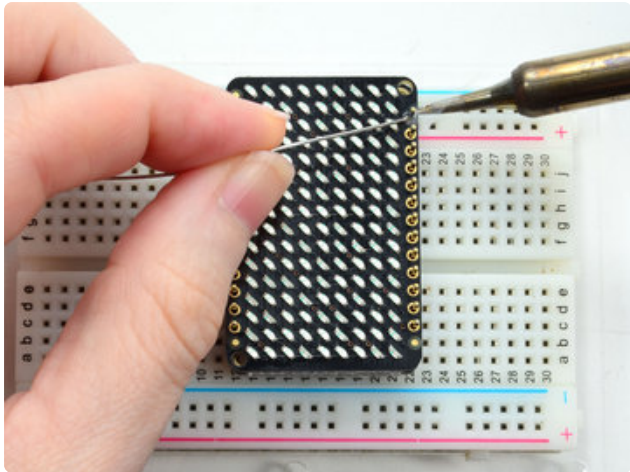
Attach LED panel

Now we'll sandwich on the charlieplexed LED panel

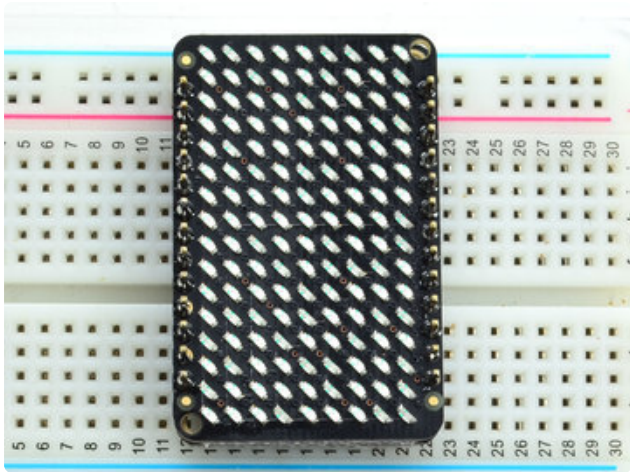


The LEDs face out and connect to the two side header strips.

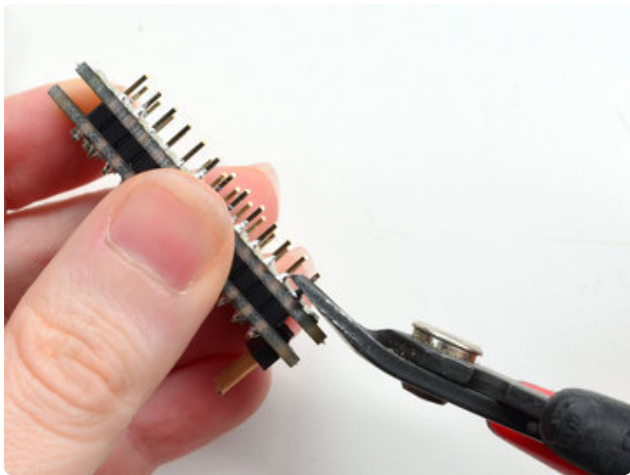
The panel is **symmetric** - you can flip it around either way and it will work fine



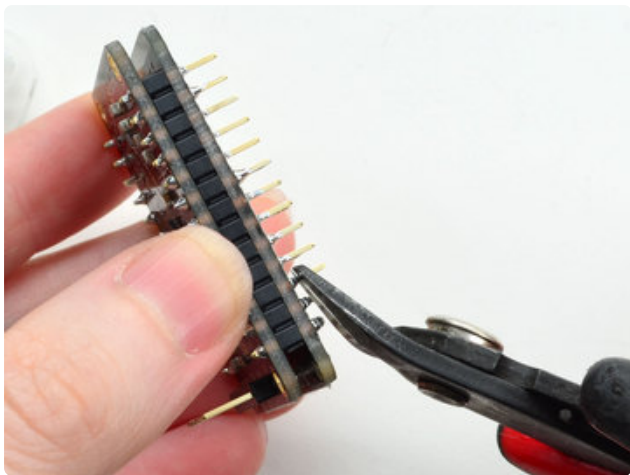
Solder in the two long header strips. Not all are connected on the LED matrix but it makes the connections mechanically stable.



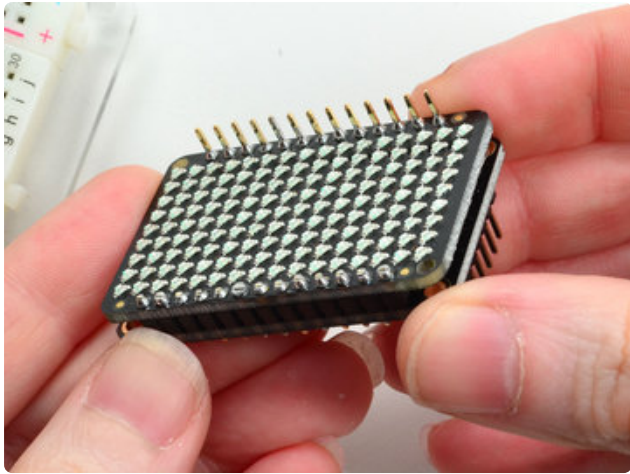
Check your solder joints visually and continue onto the next steps



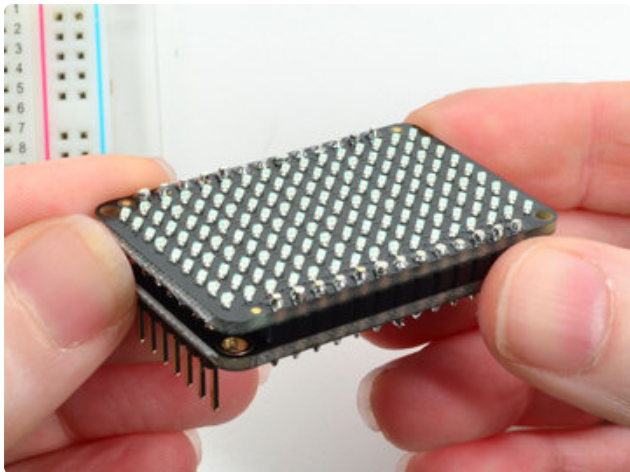
Now you can trim the long header with diagonal cutters. Cut one or two pins at a time



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

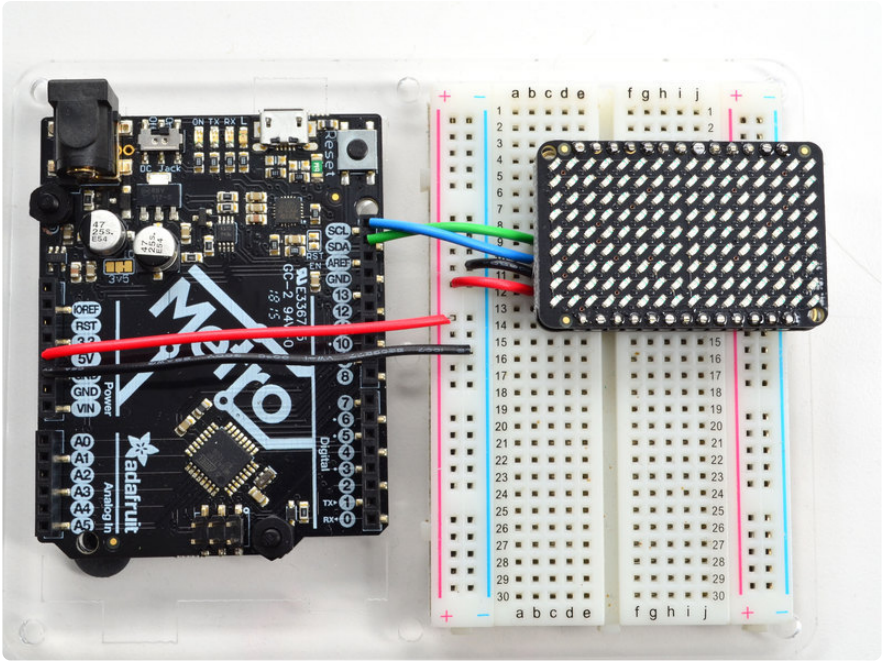


Cut both sides down for the best look



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

Arduino Wiring & Test

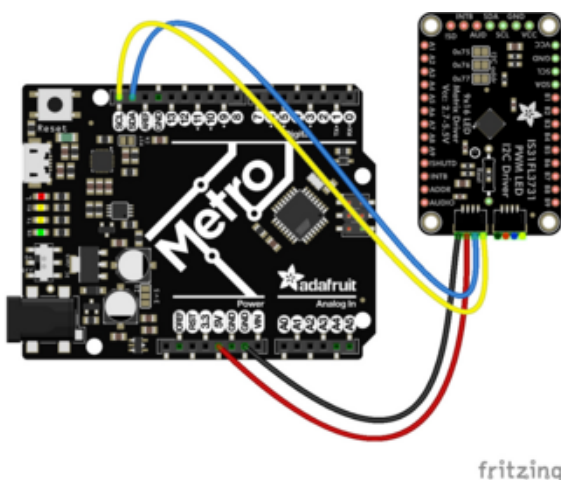


You can easily wire this breakout to any microcontroller, we'll be using an Arduino. For another kind of microcontroller, as long as you have I2C pins available, just check out the library, then port the code.

Wiring

Wire as shown for a **5V** board like an Uno. If you are using a **3V** board, like an Adafruit Feather, wire the board's 3V pin to breakout VIN.

Here is an Adafruit Metro wired up to the LED driver using the STEMMA JST PH cable:

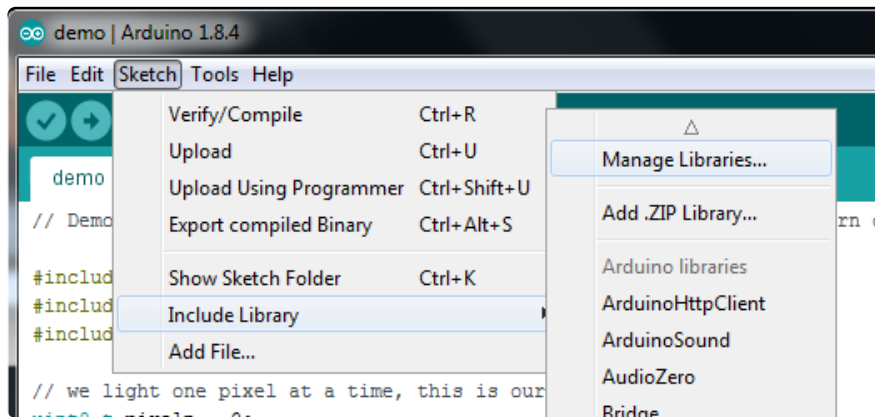


Board 5V to breakout VIN
Board GND to breakout GND
Board SCL to breakout SCL
Board SDA to breakout SDA

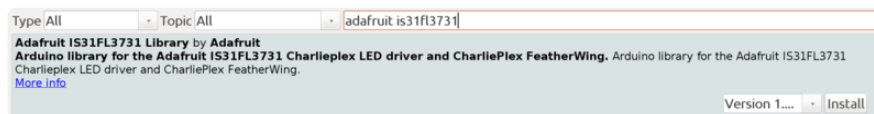
Download Libraries

To begin reading sensor data, you will need to download the **Adafruit IS31FL3731** library from the Arduino library manager.

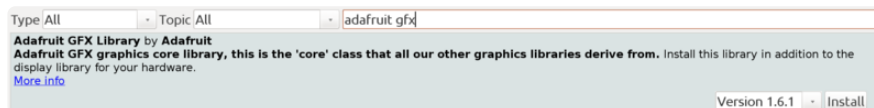
Open up the Arduino library manager:



Search for the **Adafruit IS31FL3731** library and install it



Search for the **Adafruit GFX** library and install it



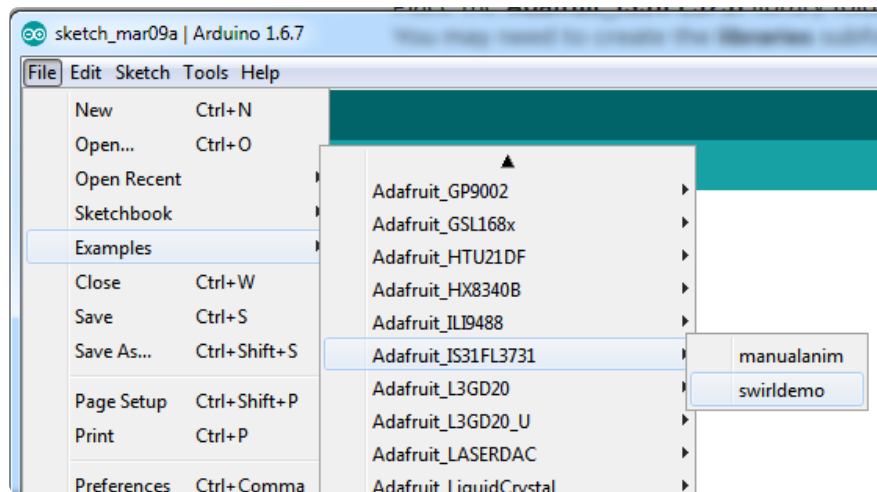
If using an older (pre-1.8.10) Arduino IDE, locate and install **Adafruit_BusIO** (newer versions do this one automatically).

We also have a great tutorial on Arduino library installation at:

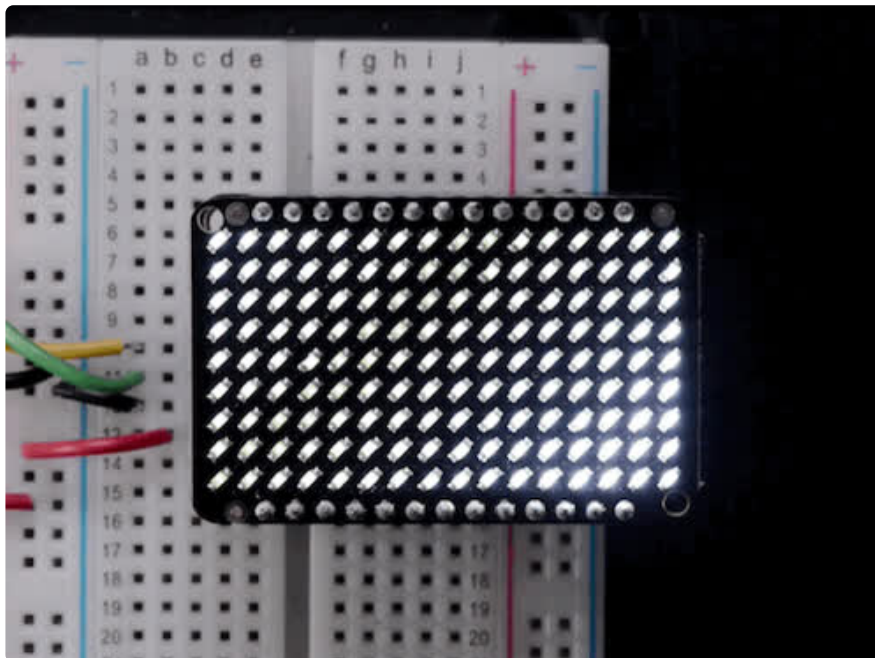
<http://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use> (<https://adafru.it/aYM>)

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> (<https://adafru.it/aPx>) 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);
```

Python & CircuitPython

It's easy to use the IS31FL3731 Charlieplex breakout, the Charlieplex FeatherWing, and the CharliePlex Bonnet with Python or CircuitPython and the [Adafruit CircuitPython IS31FL3731 \(https://adafru.it/zIE\)](https://adafru.it/zIE) module. This module allows you to easily write Python code that does all sorts of fun things with the LED matrix.

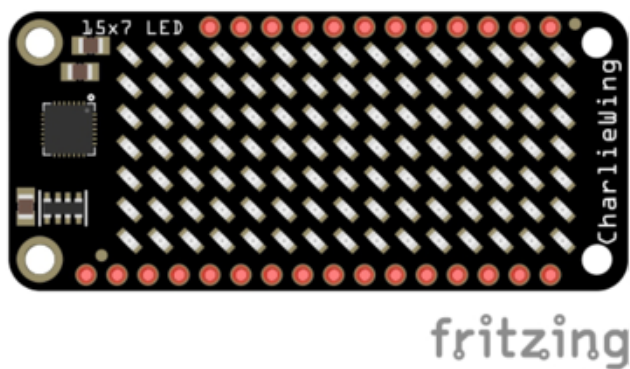
You can use CharliePlex LED matrices with any CircuitPython microcontroller board or with a computer that has GPIO and Python [thanks to Adafruit_Blinka, our CircuitPython-for-Python compatibility library \(https://adafru.it/BSN\)](https://adafru.it/BSN).

CircuitPython Microcontroller Wiring

First wire up a IS31FL3731 breakout to your board exactly as shown on the previous pages for Arduino.

For the FeatherWing, solder on the headers, and attach to the Feather.

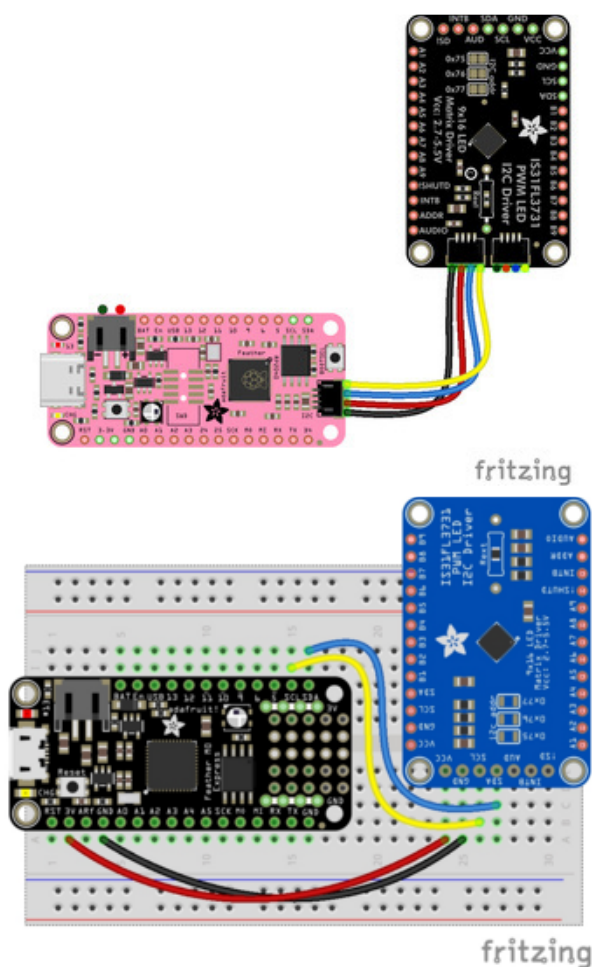
Here is the CharlieWing on a Feather M4:



Assemble the CharlieWing by soldering headers onto the board.

Once assembled, plug it into a Feather!

Here's an example of wiring a Feather to the breakout with I2C:



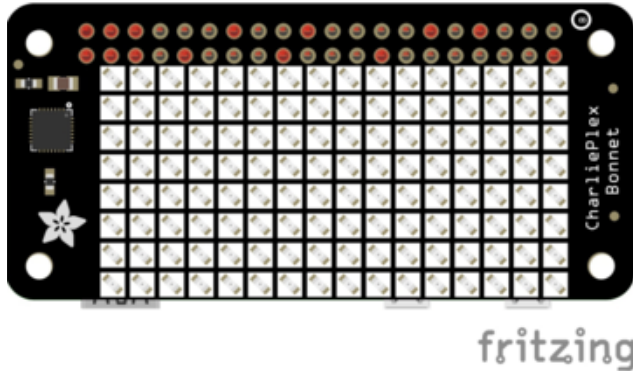
Board 3V to breakout VCC
Board GND to breakout GND
Board SCL to breakout SCL
Board SDA to breakout SDA

Python Computer Wiring

Since there's dozens of Linux computers/boards you can use we will show wiring for Raspberry Pi. For other platforms, [please visit the guide for CircuitPython on Linux to see whether your platform is supported](https://adafru.it/BSN) (<https://adafru.it/BSN>).

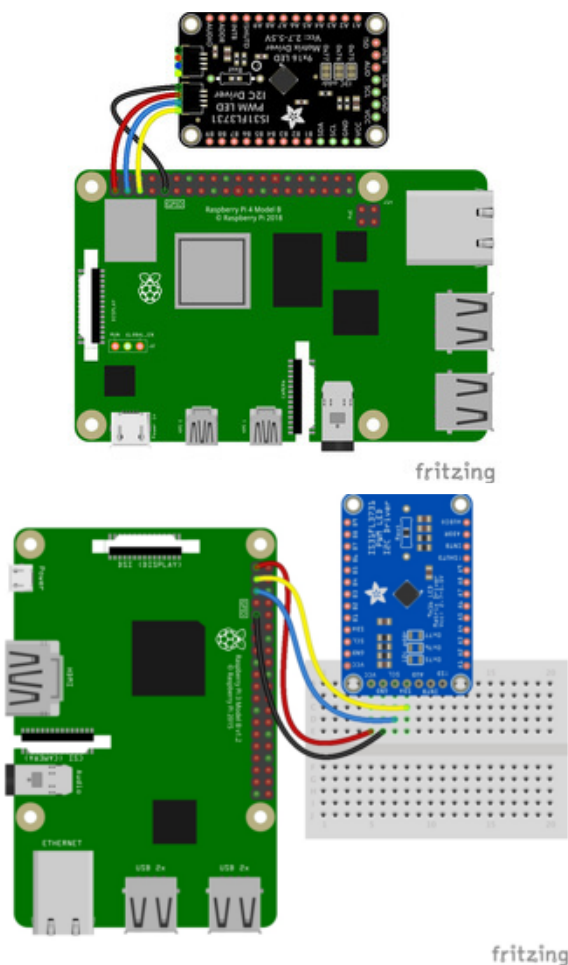
For the Bonnet, simply attach the Bonnet to your Raspberry Pi header.

Here is the CharliePlex Bonnet on a Raspberry Pi Zero:



The CharliePlex Bonnet comes fully assembled. Simply plug it into your Raspberry Pi!

Here's the Raspberry Pi wired to the breakout with I2C:



Pi 3V3 to breakout VIN
Pi GND to breakout GND
Pi SCL to breakout SCL
Pi SDA to breakout SDA

Python Installation of IS31FL3731 Library

You'll need to install the Adafruit_Blinka library that provides the CircuitPython support in Python. This may also require enabling I2C on your platform and verifying you are running Python 3. [Since each platform is a little different, and Linux changes often, please visit the CircuitPython on Linux guide to get your computer ready \(https://adafru.it/BSN\)](https://adafru.it/BSN)!

Once that's done, from your command line run the following command:

- `sudo pip3 install adafruit-circuitpython-is31fl3731 adafruit-circuitpython-framebuf`

If your default Python is version 3 you may need to run 'pip' instead. Just make sure you aren't trying to use CircuitPython on Python 2.x, it isn't supported!

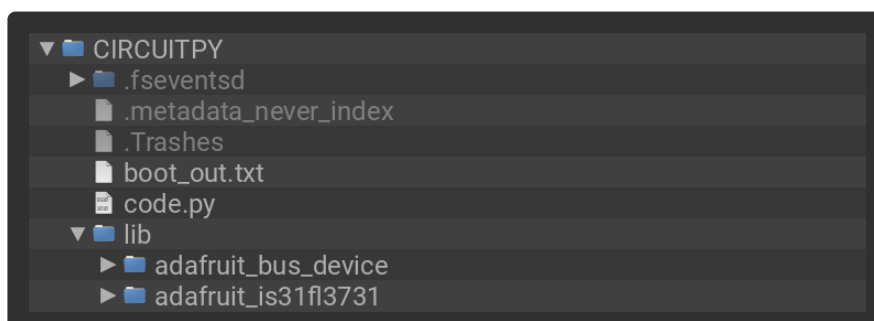
CircuitPython Installation of IS31FL3731 Library

You'll need to install the [Adafruit CircuitPython IS31FL3731 \(https://adafru.it/zIE\)](https://adafru.it/zIE) library, and its dependencies, into the **lib** folder on your **CIRCUITPY** drive. Then you need to update **code.py** with the example script.

Thankfully, we can do this in one go. In the example below, click the **Download Project Bundle** button below to download the necessary libraries and the **code.py** file in a zip file. Extract the contents of the zip file, and copy the **entire lib folder** and the **code.py** file to your **CIRCUITPY** drive.

Your **CIRCUITPY/lib** folder should contain the following folders:

- `/adafruit_is31fl3731`
- `/adafruit_bus_device`



Full Example Code

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import board
import busio

# uncomment next line if you are using Feather CharlieWing LED 15 x 7
from adafruit_is31fl3731.charlie_wing import CharlieWing as Display

# uncomment next line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
# from adafruit_is31fl3731.matrix import Matrix as Display
# uncomment next line if you are using Adafruit 16x8 Charlieplexed Bonnet
# from adafruit_is31fl3731.charlie_bonnet import CharlieBonnet as Display
# uncomment next line if you are using Pimoroni Scroll Phat HD LED 17 x 7
# from adafruit_is31fl3731.scroll_phat_hd import ScrollPhatHD as Display
# uncomment next line if you are using Pimoroni 11x7 LED Matrix Breakout
# from adafruit_is31fl3731.matrix_11x7 import Matrix11x7 as Display

# uncomment this line if you use a Pico, here with SCL=GP21 and SDA=GP20.
# i2c = busio.I2C(board.GP21, board.GP20)

i2c = busio.I2C(board.SCL, board.SDA)

display = Display(i2c)

# draw a box on the display
# first draw the top and bottom edges
for x in range(display.width):
    display.pixel(x, 0, 50)
    display.pixel(x, display.height - 1, 50)
# now draw the left and right edges
for y in range(display.height):
    display.pixel(0, y, 50)
    display.pixel(display.width - 1, y, 50)
```

CircuitPython & Python Usage

To demonstrate the usage of the sensor we'll initialize it and manipulate the LED matrix from the board's Python REPL.

To do this, [connect to the board's serial REPL \(https://adafru.it/Awz\)](https://adafru.it/Awz) so you are at the CircuitPython >>> prompt.

NOTE: Due to size and design of each CharliePlex matrix form-factor, import and initialisation is different for each. Make sure you're running the correct code for your matrix!

First, run the following code to import the necessary modules:

```
import board
import busio
```


If you're using the CharliePlex breakout, initialise it by running the following code:

```
from adafruit_is31fl3731.matrix import Matrix as Display
```

If you're using the CharliePlex FeatherWing, run the following code:

```
from adafruit_is31fl3731.charlie_wing import CharlieWing as Display
```

If you're using the CharliePlex Bonnet, run the following code:

```
from adafruit_is31fl3731.charlie_bonnet import CharlieBonnet as Display
```

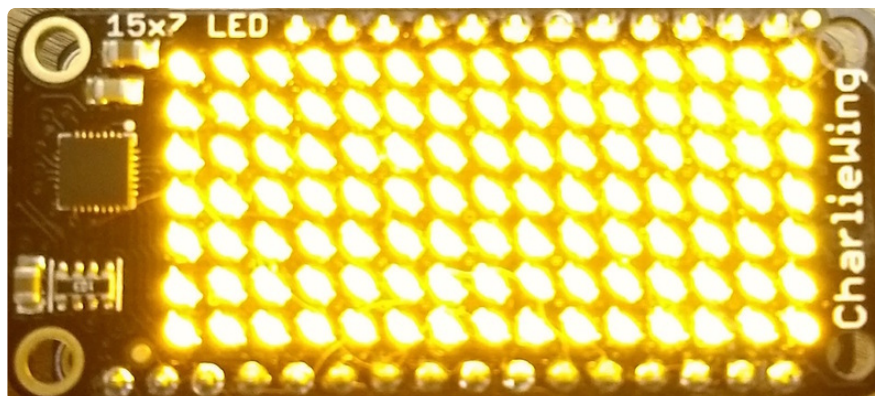
Now, no matter which board you are using, you'll create the I2C object and pass that into `Display`.

```
i2c = busio.I2C(board.SCL, board.SDA)
display = Display(i2c)
```

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)
```

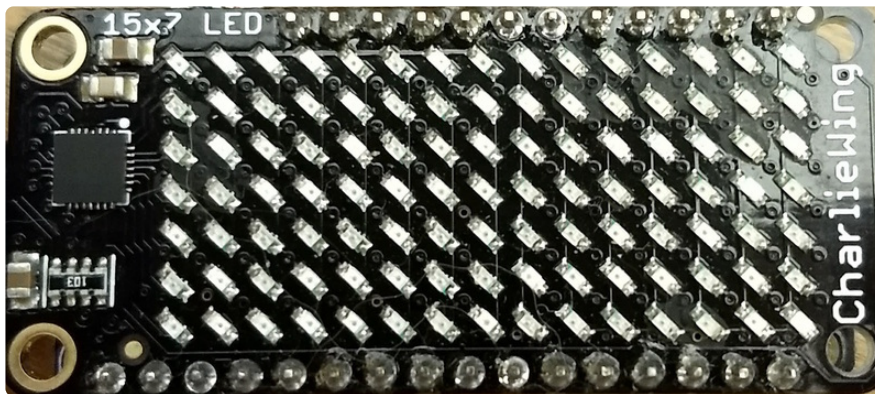


You might notice some buzzing or ringing sounds from the display when all pixels are lit, this is normal as the Charlieplex driver quickly switches LEDs on and off.

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 with `fill` set to `0`:

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



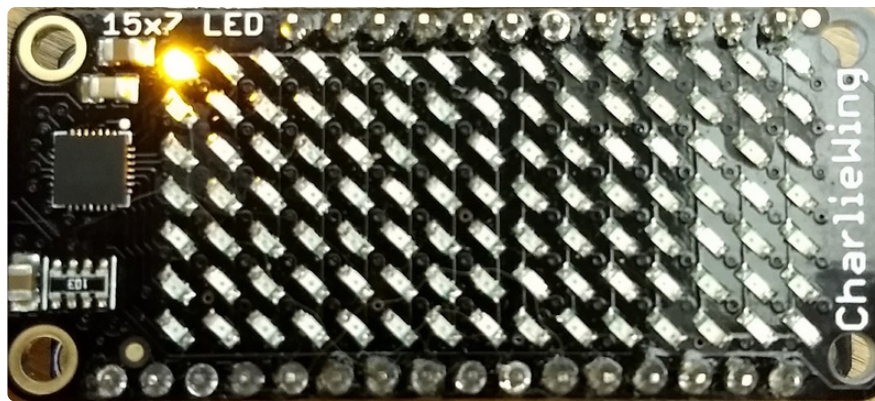
Be careful setting all pixels to 255 maximum brightness! This might pull more power than your computer's USB port can provide if you are powering your board over USB. Use an external powers supply or battery when lighting lots of LEDs to max brightness.

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.

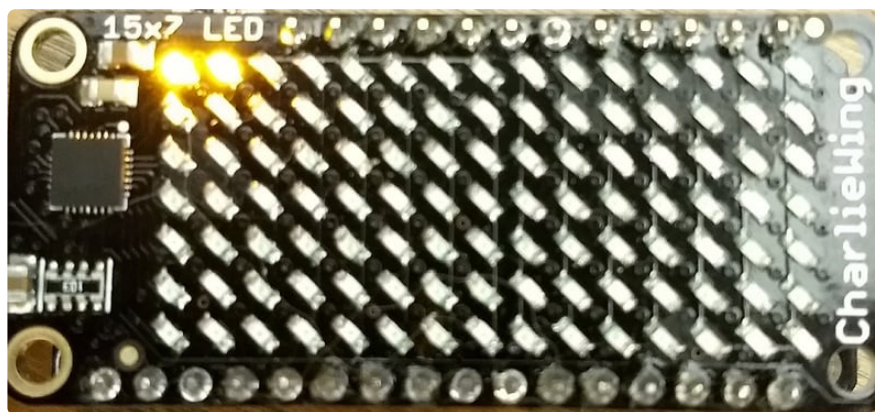
For example to set pixel 0, 0 to full brightness run:

```
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)
```

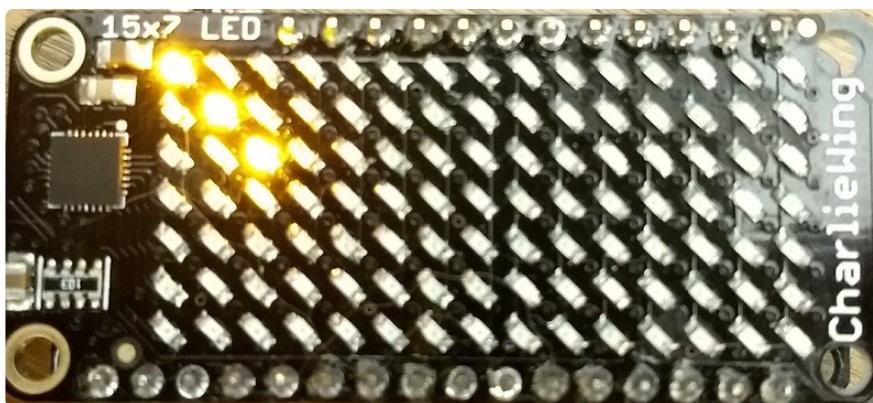
Currently the Charlieplex module is very simple and only exposes pixel set commands. In the future more advanced graphics commands like line drawing, text display, etc. might be implemented but for now you'll need to manipulate the pixels yourself.

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!

Text Scrolling Example

NOTE: When running this example on Raspberry Pi, you must have the font8x5.bin file found [here](https://adafru.it/Edh) (<https://adafru.it/Edh>) in the same directory as the program!

```
wget https://raw.githubusercontent.com/adafruit/Adafruit_CircuitPython_framebuf/master/examples/font5x8.bin
```

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import board
import busio
import adafruit_framebuf

# uncomment next line if you are using Feather CharlieWing LED 15 x 7
# from adafruit_is31fl3731.charlie_wing import CharlieWing as Display
# uncomment next line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
# from adafruit_is31fl3731.matrix import Matrix as Display
# uncomment next line if you are using Adafruit 16x8 Charlieplexed Bonnet
from adafruit_is31fl3731.charlie_bonnet import CharlieBonnet as Display

# uncomment next line if you are using Pimoroni Scroll Phat HD LED 17 x 7
# from adafruit_is31fl3731.scroll_phat_hd import ScrollPhatHD as Display
# uncomment next line if you are using Pimoroni 11x7 LED Matrix Breakout
# from adafruit_is31fl3731.matrix_11x7 import Matrix11x7 as Display

# uncomment this line if you use a Pico, here with SCL=GP21 and SDA=GP20.
# i2c = busio.I2C(board.GP21, board.GP20)

i2c = busio.I2C(board.SCL, board.SDA)

display = Display(i2c)

text_to_show = "Adafruit!!"

# Create a framebuffer for our display
buf = bytearray(32) # 2 bytes tall x 16 wide = 32 bytes (9 bits is 2 bytes)
fb = adafruit_framebuf.FrameBuffer(
    buf, display.width, display.height, adafruit_framebuf.MVLSB
)

frame = 0 # start with frame 0
while True:
    for i in range(len(text_to_show) * 9):
        fb.fill(0)
        fb.text(text_to_show, -i + display.width, 0, color=1)

        # to improve the display flicker we can use two frame
        # fill the next frame with scrolling text, then
        # show it.
        display.frame(frame, show=False)
        # turn all LEDs off
        display.fill(0)
        for x in range(display.width):
            # using the FrameBuffer text result
            bite = buf[x]
            for y in range(display.height):
```

```
        bit = 1 << y & bite
        # if bit > 0 then set the pixel brightness
        if bit:
            display.pixel(x, y, 50)

# now that the frame is filled, show it.
display.frame(frame, show=True)
frame = 0 if frame else 1
```

Python Examples

If you want to expand the capabilities of the CharliePlex LED Matrix even more, we can add Pillow into the mix. So we'll show you how to add Pillow and then go over a couple of examples that use Pillow.

Additional Setup

If you haven't already installed the library, follow the setup section on the Python & CircuitPython page. If you have, then continue.

DejaVu TTF Font

Raspberry Pi usually comes with the DejaVu font already installed, but in case it didn't, you can run the following to install it:

- `sudo apt-get install ttf-dejavu`

Pillow Library

We also need Pillow, also known as PIL, the Python Imaging Library, to allow using text with custom fonts. There are several system libraries that PIL relies on, so installing via a package manager is the easiest way to bring in everything:

- `sudo apt-get install python3-pil`

That's it. You should be ready to go.

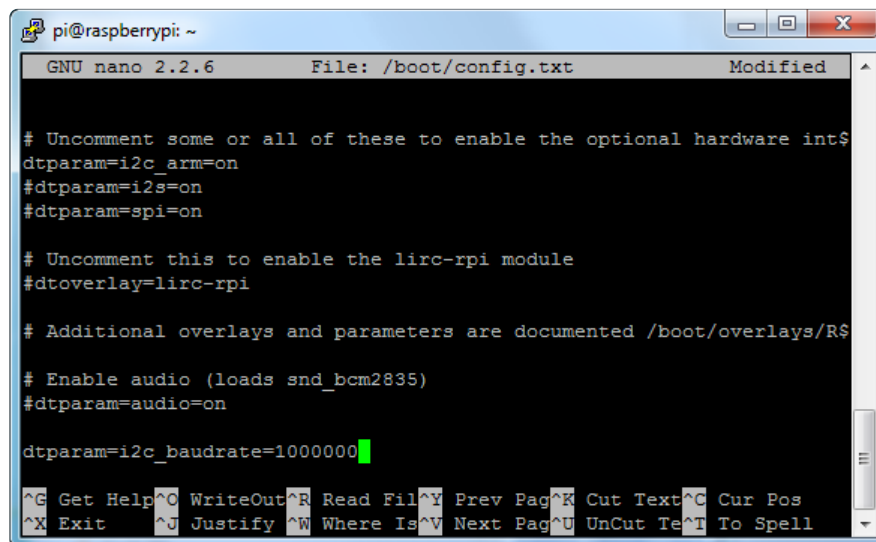
Speeding up the Display on Raspberry Pi

For the best performance, especially if you are doing fast animations, you'll want to tweak the I2C core to run at 1MHz. By default it may be 100KHz or 400KHz

To do this, edit the config with `sudo nano /boot/config.txt`

and add to the end of the file

```
dtparam=i2c_baudrate=1000000
```



Reboot to 'set' the change.

Scrolling Marquee Example

The first example, we're going to take a look at an example that will take some text, draw it in a TrueType font and then scroll the rendered text. Let's start by looking at the code in each section.

We start by importing the libraries we need which include the board and a few Pillow modules.

```
import board
from PIL import Image, ImageDraw, ImageFont
```

Next we do the import for the IS31FL3731 driver for the matrix itself. Since the different boards have been split into their own modules, we just import the appropriate module and alias it as `Display`.

For instance, if you have the breakout instead of the bonnet, you'll want to uncomment that and comment out the bonnet line.

```
# uncomment next line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
# from adafruit_is31fl3731.matrix import Matrix as Display
# uncomment next line if you are using Adafruit 16x8 Charlieplexed Bonnet
```

```
from adafruit_is31fl3731.charlie_bonnet import CharlieBonnet as Display

# uncomment next line if you are using Pimoroni Scroll Phat HD LED 17 x 7
# from adafruit_is31fl3731.scroll_phat_hd import ScrollPhatHD as Display
```

Next we set a couple of variables. We have the **SCROLLING_TEXT** variable. Go ahead and change the text if you would like. It shouldn't matter how long, though you probably shouldn't make it too long if you want to see it loop. You can set **BRIGHTNESS** as well, in case you want to adjust the intensity.

```
SCROLLING_TEXT = "You can display a personal message here..."
BRIGHTNESS = 64 # Brightness can be between 0-255
```

Next we do the basic setup for the display by declaring the I2C object and passing that into the display.

```
i2c = board.I2C()

display = Display(i2c)
```

Next we go ahead and load up the Deja Vu font into an object. We are going with an 8 pixel high font because that's the largest we can fit on the display and still see everything.

```
# Load a font
font = ImageFont.truetype('/usr/share/fonts/truetype/dejavu/DejaVuSans.ttf', 8)
```

In this next part, we first start by getting the width and height of what the text would be when rendered with the font we chose. Then we create a virtual image of that width and height and draw the text onto it.

```
# Create an image that contains the text
text_width, text_height = font.getsize(SCROLLING_TEXT)
text_image = Image.new('L', (text_width, text_height))
text_draw = ImageDraw.Draw(text_image)
text_draw.text((0, 0), SCROLLING_TEXT, font=font, fill=BRIGHTNESS)
```

Next we create a virtual image that's the same size as the display. This will be where we draw what we want to actually display.

```
# Create an image for the display
image = Image.new('L', (display.width, display.height))
draw = ImageDraw.Draw(image)
```

Finally we get to our main loop. We start by drawing a rectangle to be sure we are not leaving any existing text behind. Then we **paste** our image of the text onto the image we are going to display using the value of **x**, which represents the left offset we want to use to give a nice scrolling effect. We have a **for** loop which will scroll

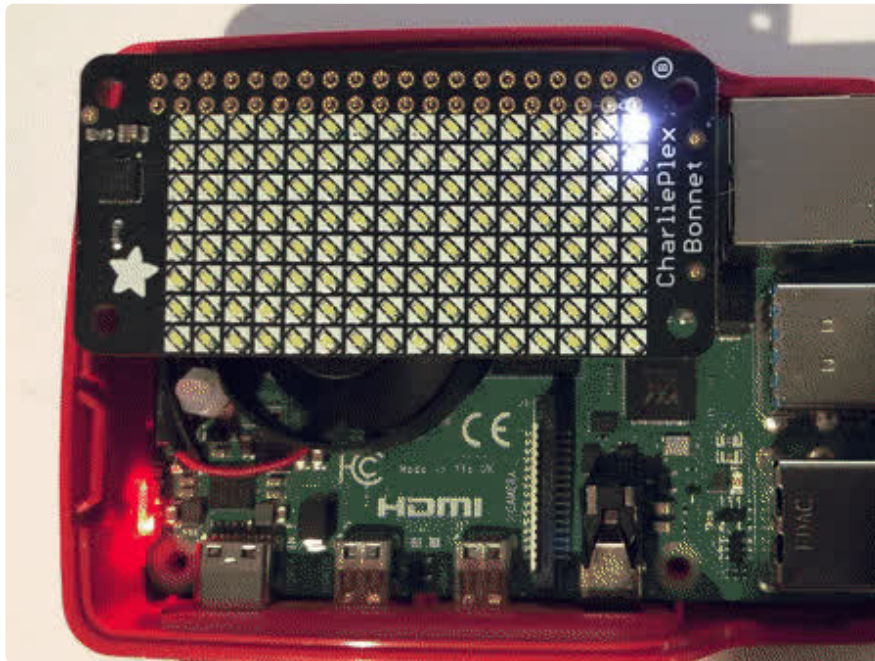
the complete text plus empty display width by one iteration. That's all placed inside an infinite `while` loop for endless iterations.

```
while True:
    for x in range(text_width + display.width):
        draw.rectangle((0, 0, display.width, display.height), outline=0, fill=0)
        image.paste(text_image, (display.width - x, display.height // 2 -
text_height // 2 - 1))
        display.image(image)
```

Now go ahead and run the example code.

```
python3 is31fl3731_pillow_marquee.py
```

You should see the display showing a message scrolling from right to left.



Full Source Code

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

"""
Example to scroll some text as a marquee

This example is for use on (Linux) computers that are using CPython with
Adafruit Blinka to support CircuitPython libraries. CircuitPython does
not support PIL/pillow (python imaging library)!

Author(s): Melissa LeBlanc-Williams for Adafruit Industries
"""

import board
from PIL import Image, ImageDraw, ImageFont
```

```

# uncomment next line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
# from adafruit_is31fl3731.matrix import Matrix as Display
# uncomment next line if you are using Adafruit 16x8 Charlieplexed Bonnet
from adafruit_is31fl3731.charlie_bonnet import CharlieBonnet as Display

# uncomment next line if you are using Pimoroni Scroll Phat HD LED 17 x 7
# from adafruit_is31fl3731.scroll_phat_hd import ScrollPhatHD as Display

SCROLLING_TEXT = "You can display a personal message here..."
BRIGHTNESS = 64 # Brightness can be between 0-255

i2c = board.I2C() # uses board.SCL and board.SDA
# i2c = board.STEMMA_I2C() # For using the built-in STEMMA QT connector on a
microcontroller

display = Display(i2c)

# Load a font
font = ImageFont.truetype("/usr/share/fonts/truetype/dejavu/DejaVuSans.ttf", 8)

# Create an image that contains the text
text_width, text_height = font.getsize(SCROLLING_TEXT)
text_image = Image.new("L", (text_width, text_height))
text_draw = ImageDraw.Draw(text_image)
text_draw.text((0, 0), SCROLLING_TEXT, font=font, fill=BRIGHTNESS)

# Create an image for the display
image = Image.new("L", (display.width, display.height))
draw = ImageDraw.Draw(image)

# Load the text in each frame
while True:
    for x in range(text_width + display.width):
        draw.rectangle((0, 0, display.width, display.height), outline=0, fill=0)
        image.paste(
            text_image, (display.width - x, display.height // 2 - text_height // 2 -
1)
        )
        display.image(image)

```

Animated GIF Example

Next let's take a look at an animated GIF player example. First we'll start by downloading an animated GIF and copying that into the same folder as the script as **adafruit-star-rotating.gif**. It looks tiny and that's because it is. It is 8x8 pixels which works out nicely for the CharliePlex matrix.



Download Rotating Star

<https://adafru.it/HAk>

Now let's start with the first section, the imports. You may be surprised that this code uses fewer Pillow modules than the previous example. We are also adding `sys`, which we mostly use for passing the name of an animated gif.

```
import sys
import board
from PIL import Image
import adafruit_is31fl3731
```

Next we do the usual setup for the CharliePlex display.

```
i2c = board.I2C()

# uncomment line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
#display = adafruit_is31fl3731.Matrix(i2c)
# uncomment line if you are using Adafruit 16x9 Charlieplexed PWM LED Matrix
display = adafruit_is31fl3731.CharlieBonnet(i2c)
```

Now we make sure the user specified a gif file, so we have something to work with that's not hard-coded and open the file. If the file wasn't specified, we are using `sys.exit()`, since that is the preferred way to do it if you are importing `sys` anyways.

```
# Check that the gif was specified
if len(sys.argv) < 2:
    print("No image file specified")
    print("Usage: python3 is31fl3731_pillow_animated_gif.py animated.gif")
    sys.exit()

# Open the gif
image = Image.open(sys.argv[1])
```

We need to check that this is an animated gif. While we could have just displayed it as a static gif in this case, the point was to show how to display the animation.

```
# Make sure it's animated
if not image.is_animated:
    print("Specified image is not animated")
    sys.exit()
```

Next we get some gif animation information such as the delay. Only the duration of the first frame is extractable at the time of this writing with Pillow.

```
# Get the autoplay information from the gif
delay = image.info['duration']
```

The loop number is a little trickier because it means different things between the IS31FL3731 chip and an animated gif. With an animated gif, it is guaranteed to play at least once and then loop by the number of times is provided by the loop value, unless it is zero, which means forever.

With the IS31FL3731, loops mean exactly the number of loops to play the animation, unless it is zero, in which case it will play forever.

So if `loop` is 0, we just pass it on. If we only want to play the animation once, then `loop` is not provided in the image information. If it is more than once, we need to count the first time it plays plus the number of times to loop the animation.

```
# Figure out the correct loop count
if "loop" in image.info:
    loops = image.info['loop']
    if loops > 0:
        loops += 1
else:
    loops = 1
```

Next, we need to make sure these values are in the ranges that the driver likes. The number of frames in the animation is available from the property `n_frames` and the IS31FL3731 can handle a maximum of 8 frames, so if a longer animation is provided, only the first 8 frames are used.

```
# IS31FL3731 only supports 0-7
if loops > 7:
    loops = 7

# Get the frame count (maximum 8 frames)
frame_count = image.n_frames
if frame_count > 8:
    frame_count = 8
```

Now that we have a frame count, we will go through each of those frames and load the frame image into the IS31FL3731 using the `paste` function and center the image. First the frame is converted to a 256-grayscale image, which is what mode L is, and then it is copied into a centered position, which is calculated from the difference in size between the display and image. After that, it is inserted as the current frame number.

```
# Load each frame of the gif onto the Matrix
for frame in range(frame_count):
    image.seek(frame)
    frame_image = Image.new('L', (display.width, display.height))
    frame_image.paste(image.convert("L"), (display.width // 2 - image.width // 2,
                                           display.height // 2 - image.height // 2))
    display.image(frame_image, frame=frame)
```

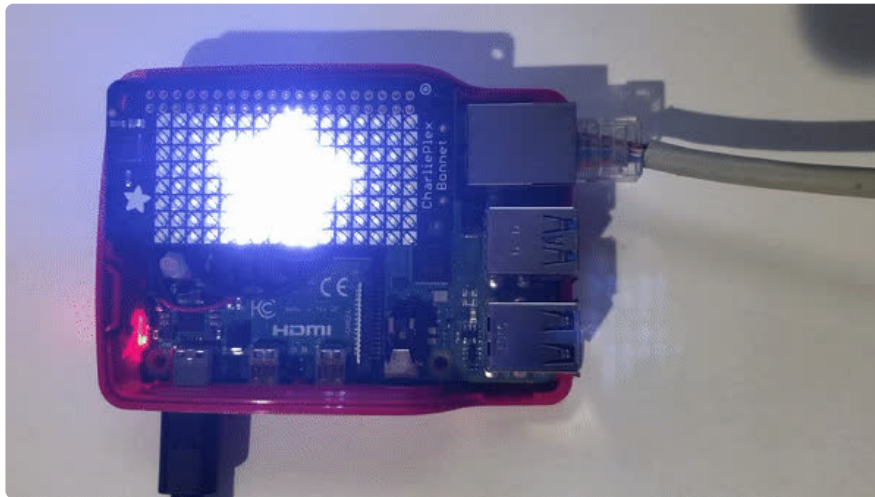
Finally, we call the `auto_play` function using the delay and loop information from the animated gif.

```
display.autoplay(delay=delay, loops=loops)
```

Now go ahead and run the example code.

```
python3 is31fl3731_pillow_animated_gif.py adafruit-star-rotating.gif
```


You should see the rotating star appear on the display.



Python Docs

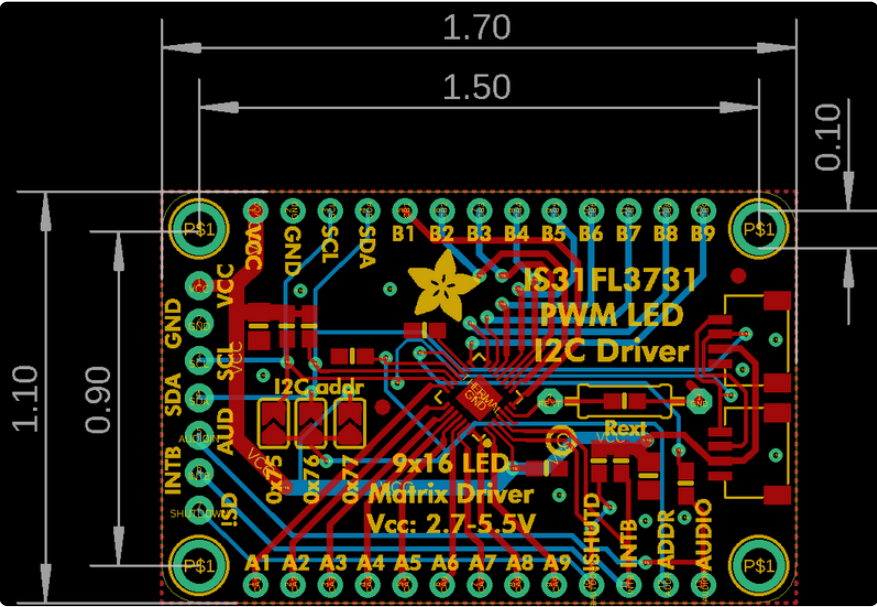
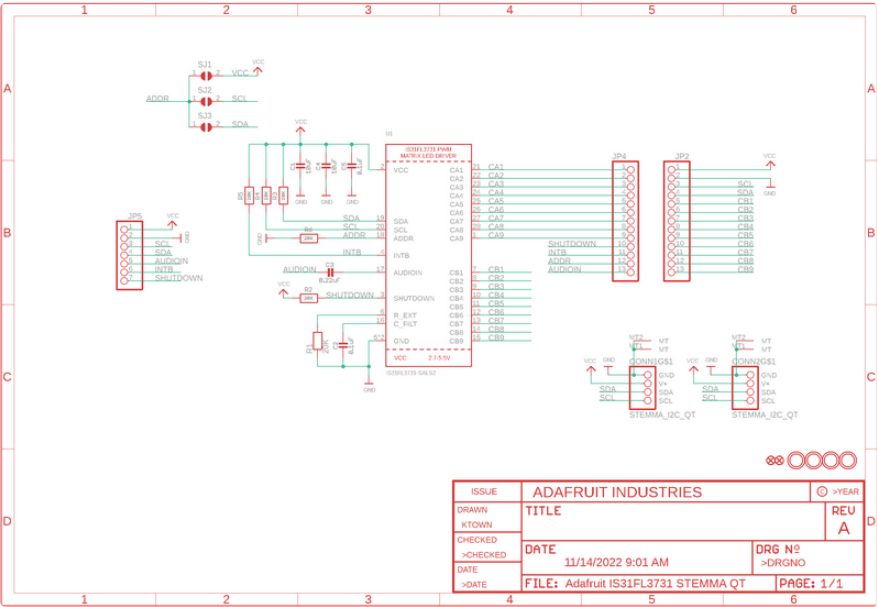
[Python Docs \(https://adafru.it/C55\)](https://adafru.it/C55)

Downloads

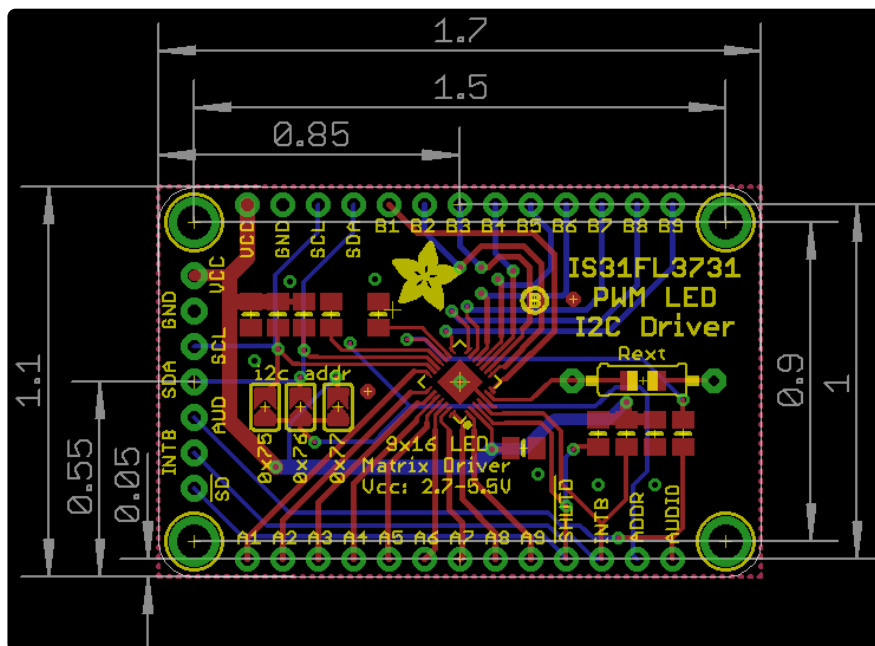
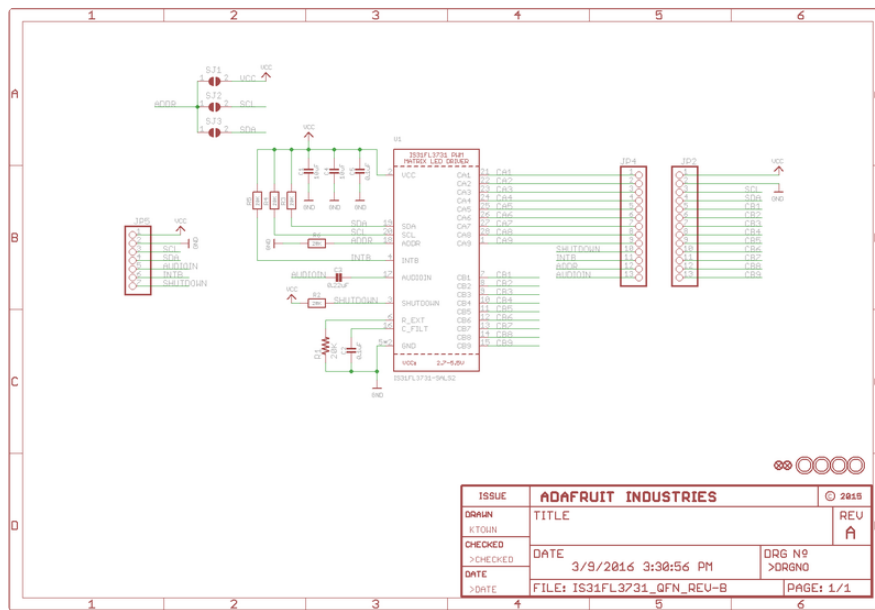
Files

- [EagleCAD PCB files on GitHub \(https://adafru.it/oja\)](https://adafru.it/oja)
- [Original Fritzing object in the Adafruit Fritzing library \(https://adafru.it/19CM\)](https://adafru.it/19CM)
- [STEMMA QT Fritzing object in the Adafruit Fritzing library \(https://adafru.it/19CN\)](https://adafru.it/19CN)
- [IS31FL3731 Datasheet \(https://adafru.it/IWC\)](https://adafru.it/IWC)

STEMMA QT Schematic and Fab Print



Original Schematic and Fab Print



16x9 0603 LED Grid

Schematics & Fabrication print (dimensions in inches)

