adafruit learning system

32x16 and 32x32 RGB LED Matrix

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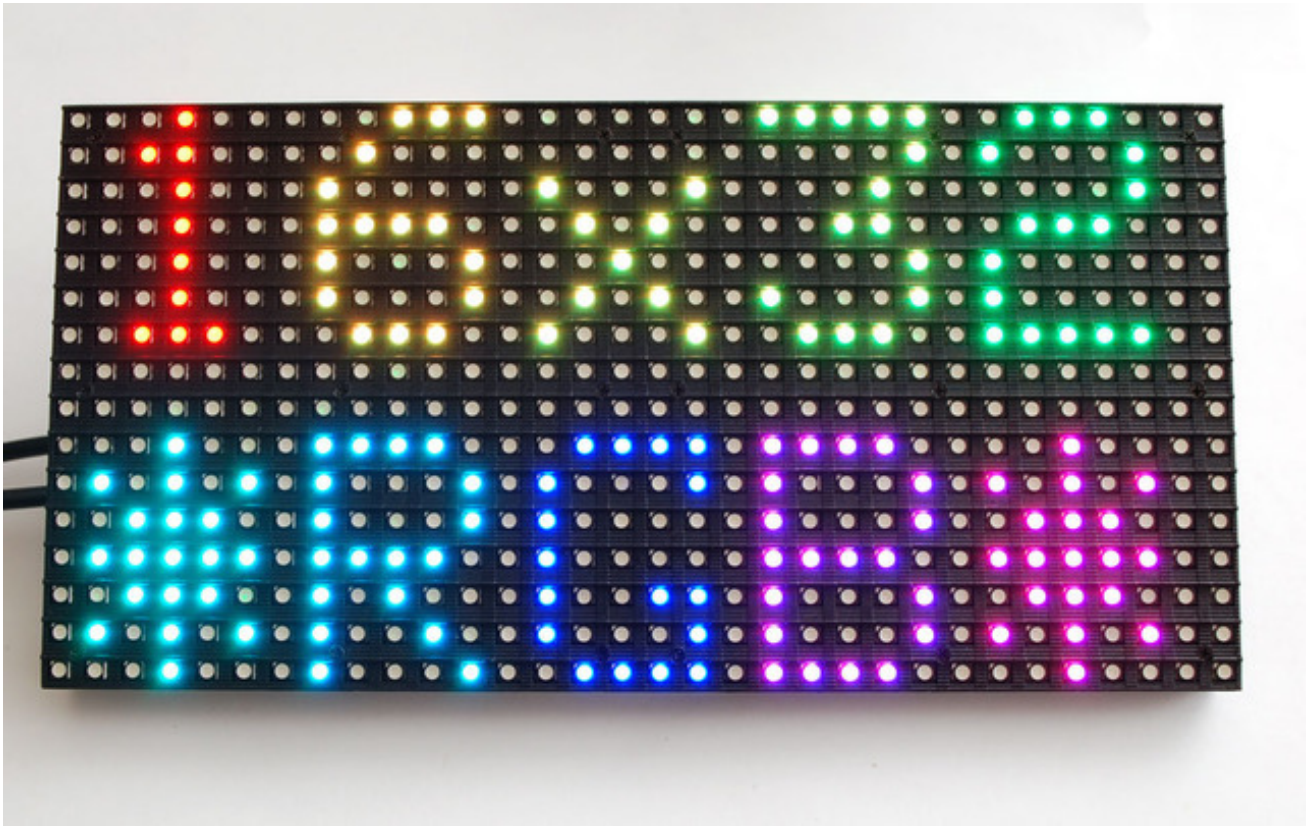
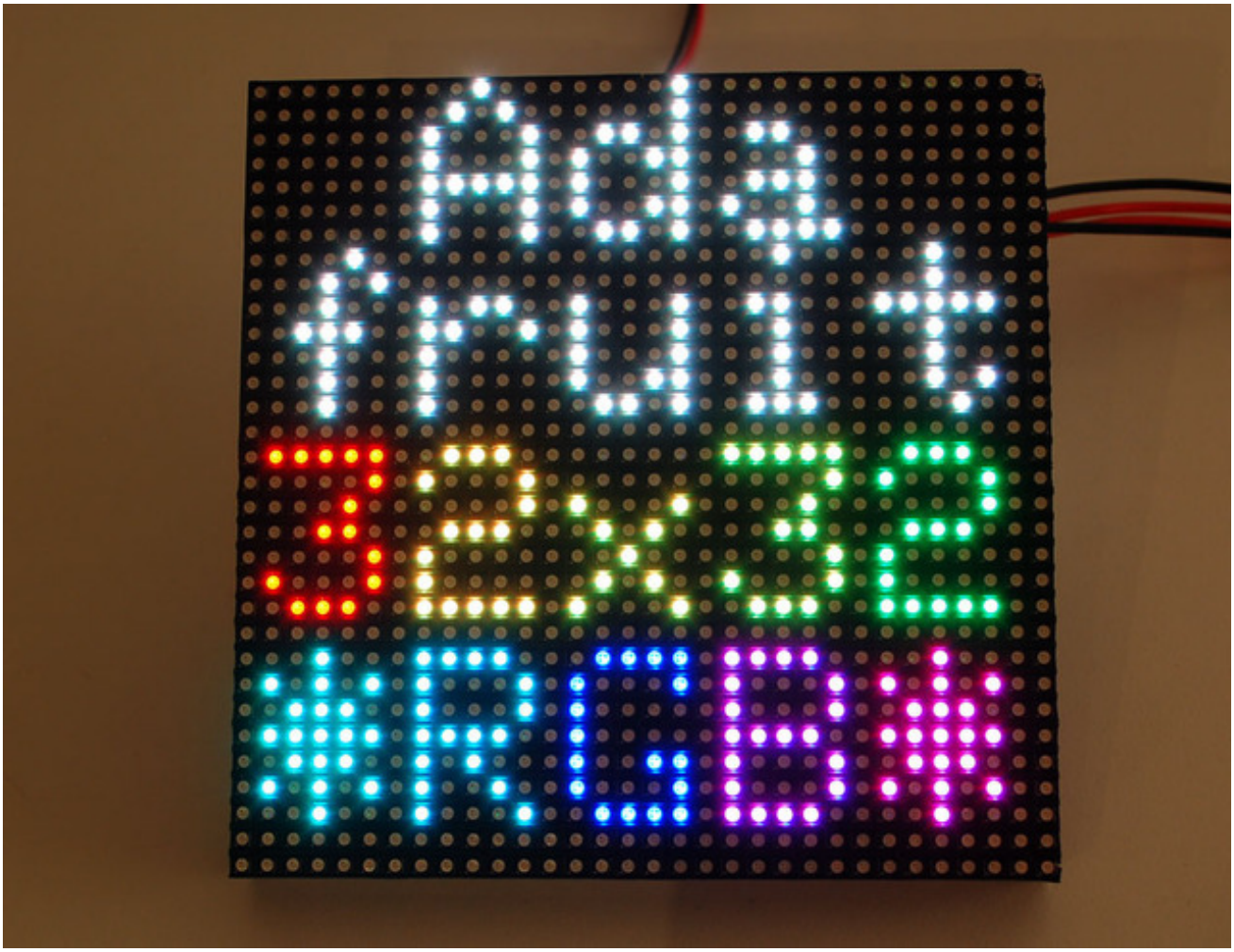
Guide Contents

Overview

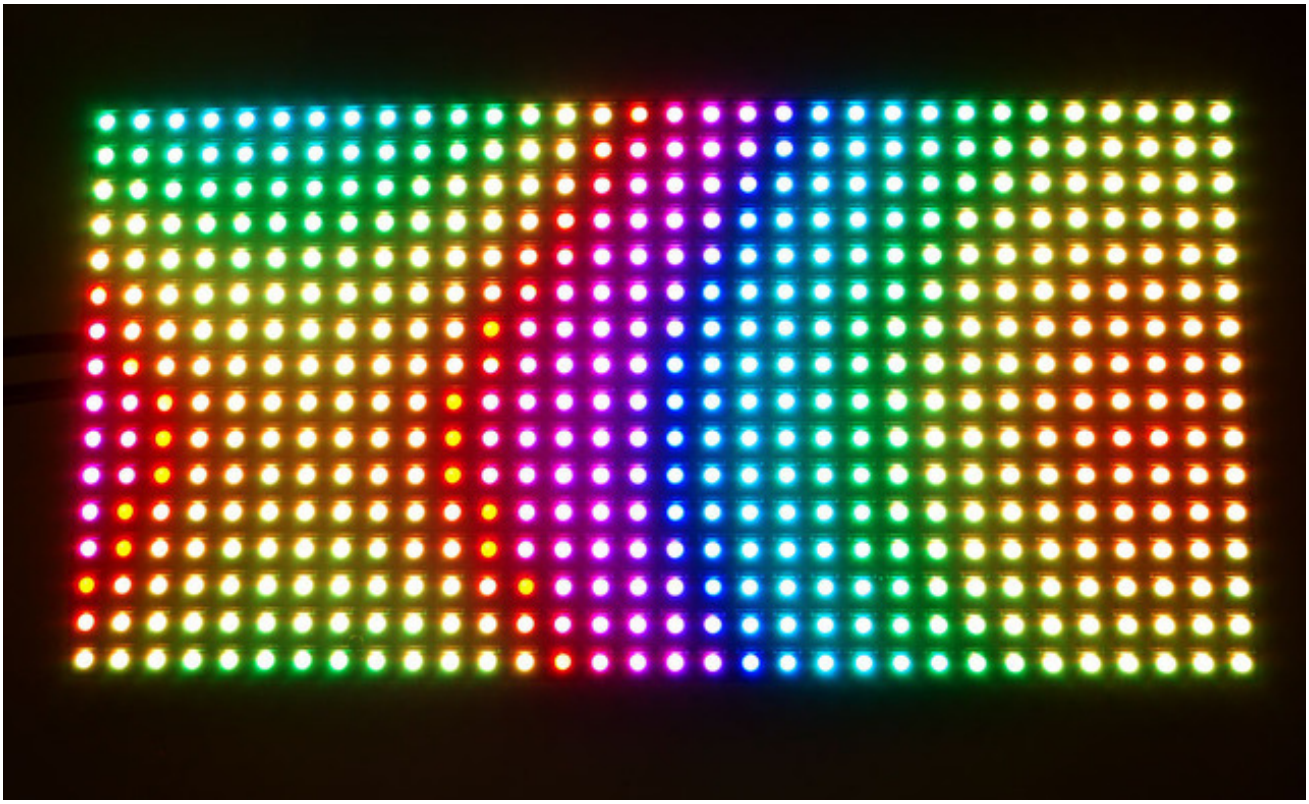
Bring a little bit of Times Square into your home with our RGB LED matrix panels. These panels are normally used to make video walls — here in New York we see them on the sides of buses and on bus stops — to display animations or short video clips. We thought they looked really cool so we picked up a few boxes from the factory. One has 512 bright RGB LEDs arranged in a 16x32 grid on the front, the other has 1024 LEDs in a 32x32 grid. On the back is a PCB with IDC connectors (one set for input, one for output: in theory you can chain these together) and 12 16-bit latches that allow you to drive the display with a 1:8 (16x32) or 1:16 (32x32) scan rate.





These panels require 12 or 13 digital pins (6 bit data, 6 or 7 bit control) and a good 5V power supply, at least a couple amps per panel. We suggest our 2A (or larger) regulated 5V adapters and either a terminal block DC jack, or solder a jack from our DC extension cord. Please read the rest of our tutorial for more details!

Keep in mind that these displays are normally designed to be driven by FPGAs or other high speed processors; they do not have built in PWM control of any kind. Instead, you're supposed to redraw the screen over and over to 'manually' PWM the whole thing. On a 16 MHz Arduino Uno, we managed to squeeze 12-bit color (4096 colors) but this display would really shine if driven by an FPGA, CPLD, Propeller, XMOS or other high speed multi-processor controller.



Of course, we wouldn't leave you with a datasheet and a "good luck!" We have a full wiring diagrams and working Arduino library code with examples from drawing pixels, lines, rectangles, circles and text. You'll get your color blasting within the hour! On an Arduino Uno or Mega, you'll need 12 digital pins, and about 800 bytes of RAM to hold the 12-bit color image (double that for the 32x32 matrix).

The library works ONLY with the Arduino Uno and Mega. Other boards (such as the Arduino Leonardo) ARE NOT SUPPORTED.

Power

Although LEDs are very efficient light sources, get enough of them in one place and the current really adds up.

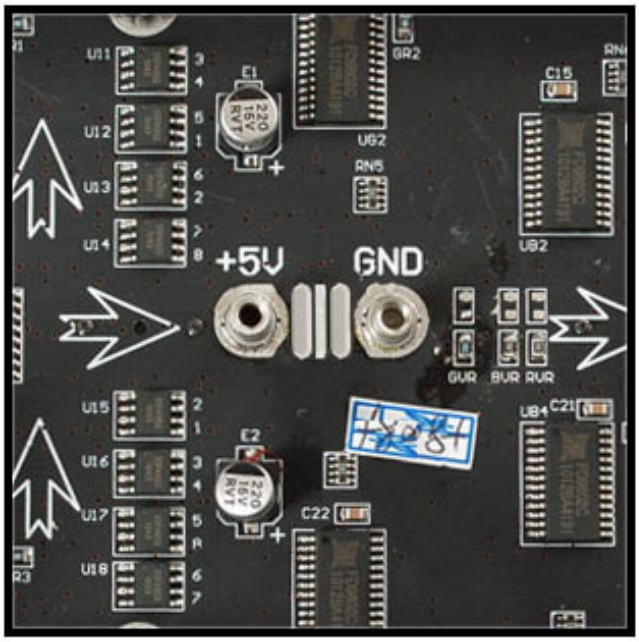
A *single* **32x16** or **32x32** RGB matrix, running full tilt (all pixels set white), can require nearly ***4 Amps*** of current! Double that figure for a **64x32** matrix.

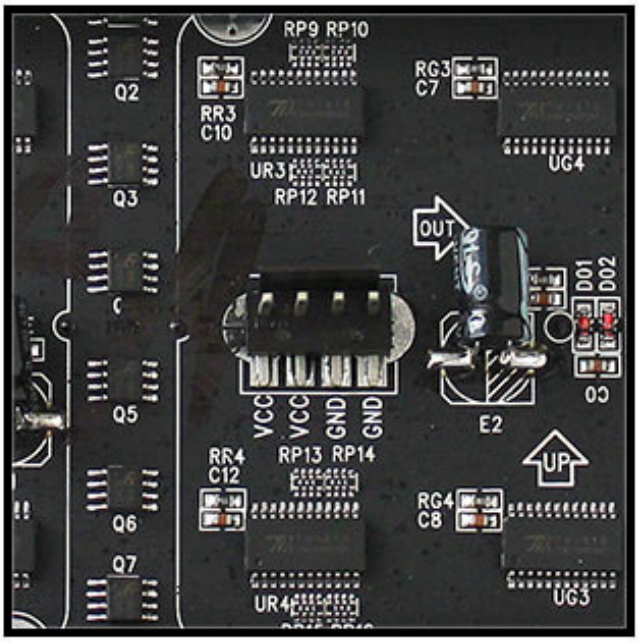
On *average* though, displaying typical graphics and animation, these panels will use less…a **2A** supply is usually sufficient for a single 32x16 or 32x32 panel, or 4A for a 64x32 panel. There's no harm in using a larger power supply rated for more *Amps* (e.g. a 10A supply), but *never* use one with a higher *Voltage* (use **5V, period**)!

On these panels, the power connection is separate from the data connection. Let's begin by connecting a 5V supply…

Our parts suppliers occasionally make revisions to designs. As a result, the connections have changed over time. We'll walk through the different wiring combinations here…pick the explanation that matches the panel(s) you received.

Two different types of power connectors have made an appearance:



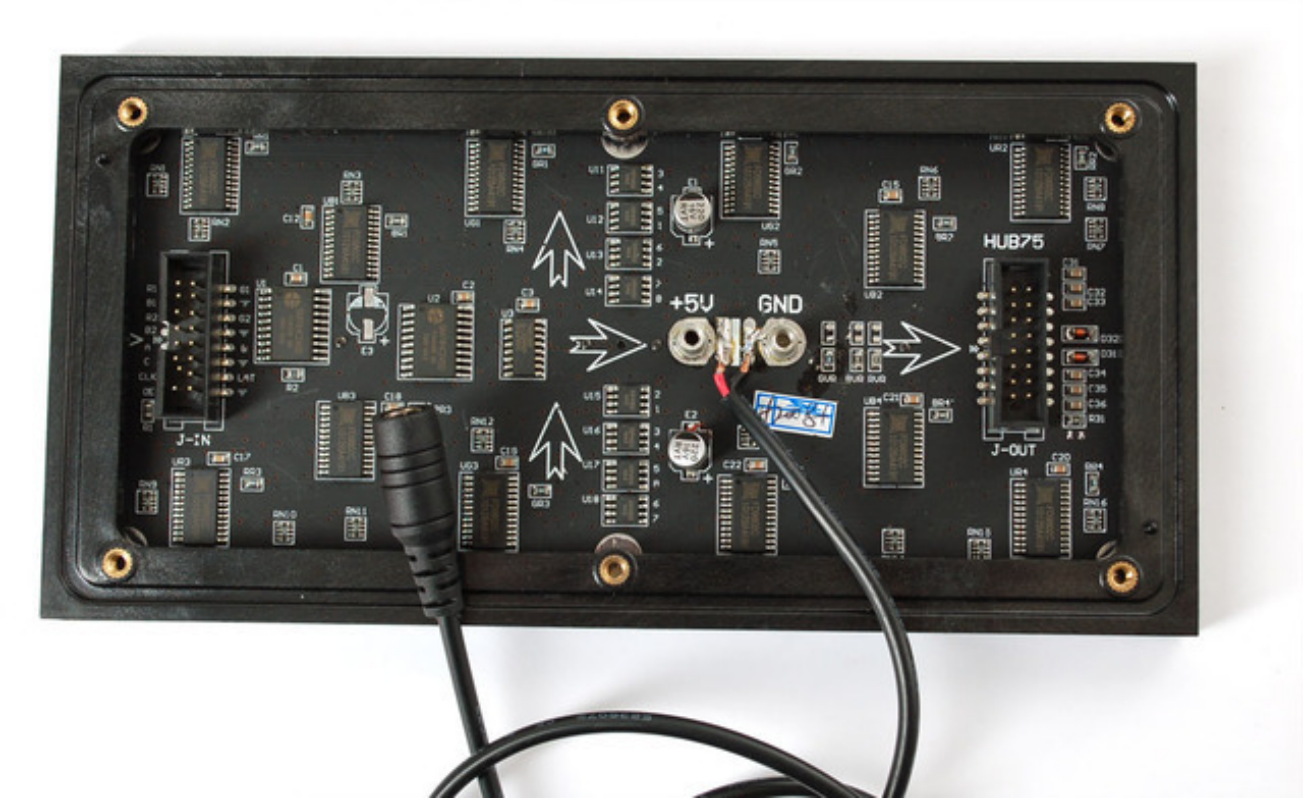


On the left is a screw post power connector (with adjacent pads for soldering wires directly). On the right, a Molex-style header. Some panels will have *two* headers…the power cable included with these panels has connectors for both headers.

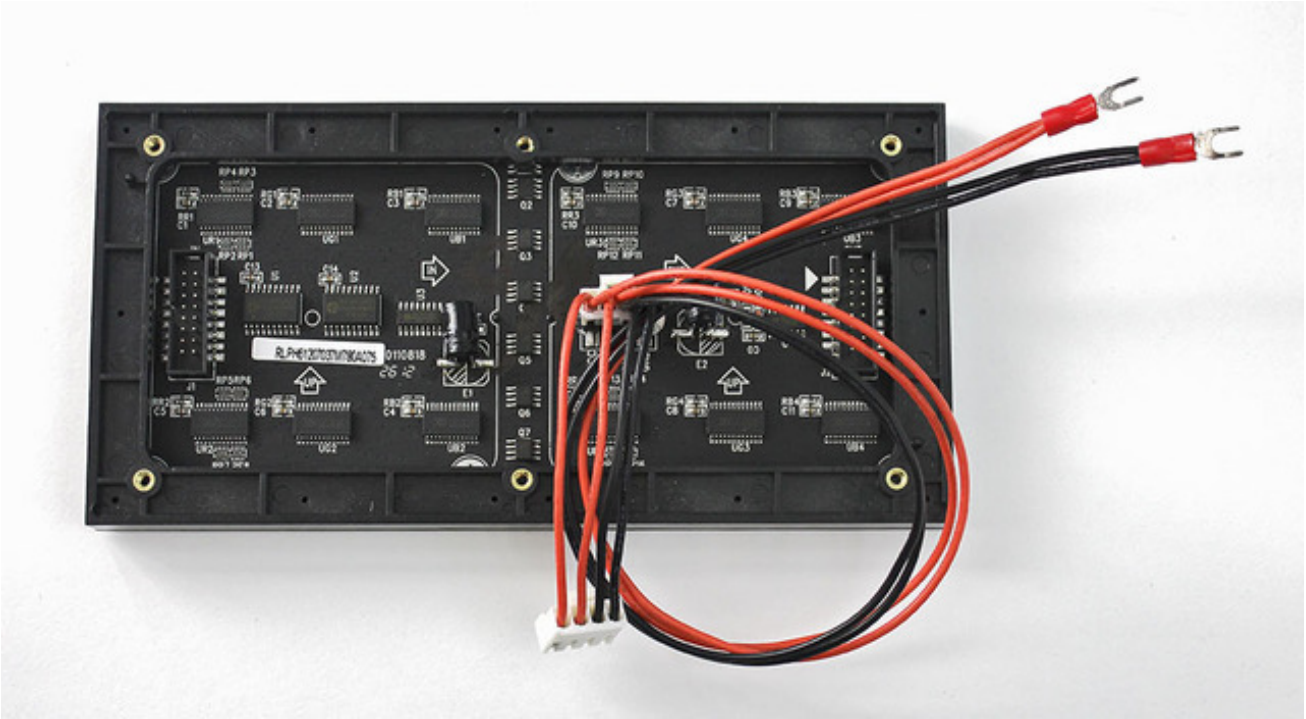
With the posts-and-pads connector, you can either screw down the spades from the power cable, or

another approach is to cut a 2.1mm jack from this extension cord (http://adafru.it/327) and solder it to the pads on the panel back. This way you can plug the 5V from a wall adapter (http://adafru.it/276) right in (the one we have in the shop is suggested). Simply cut the other half of the cable off, and strip the wiring so you can solder the red wire to +5 and the black wire to ground.

Solder both pins correctly to the power port. Make sure you get this right because there is no protection diode!

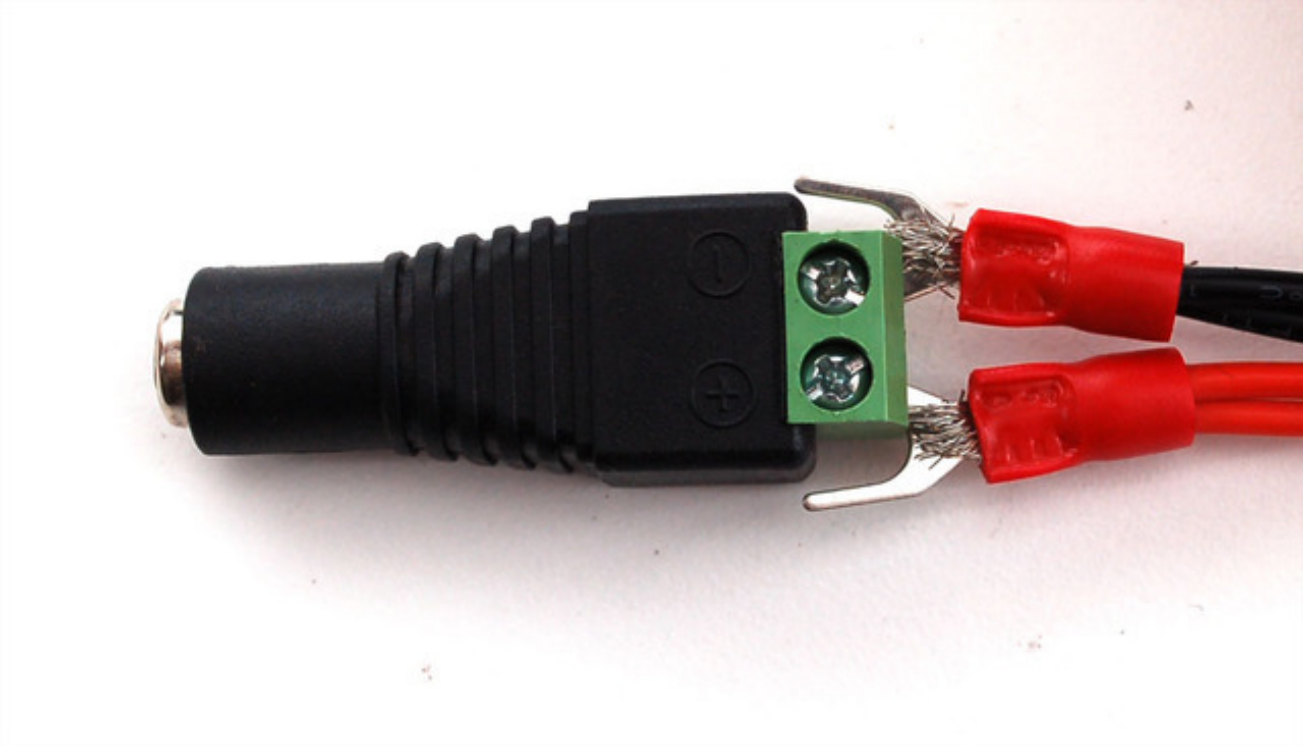


If your panel has the Molex-style header, just plug in the included power cable, observing the correct polarity.



The spades at the opposite end of this power cable can be screwed into a 2.1mm terminal block adapter. Works nicely! Don't allow the exposed connectors to contact metal though…you should

probably cover this with heat-shrink tube or electrical tape.



Connections

These panels are normally designed for *chaining* (linking end-to-end into larger displays)…the output of one panel connects to the input of the next, down the line.

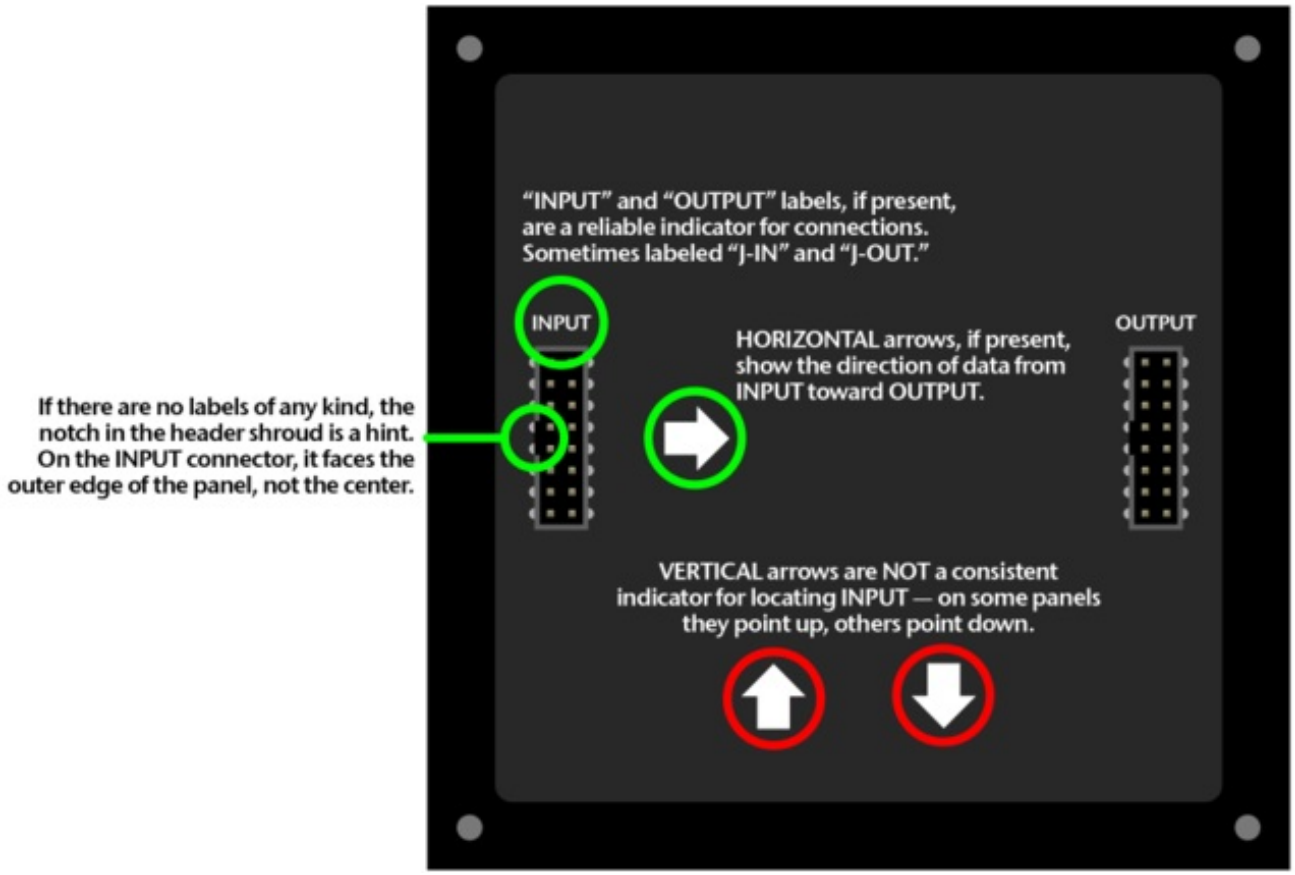
With the limited RAM in an Arduino, chaining is seldom practical. Still, **it's necessary to distinguish the input and output connections** on the panel…it won't respond if we're connected to the wrong socket.

Flip the matrix over so you're looking at the back, holding it with the two sockets situated at the **left and right edges** (not top and bottom).

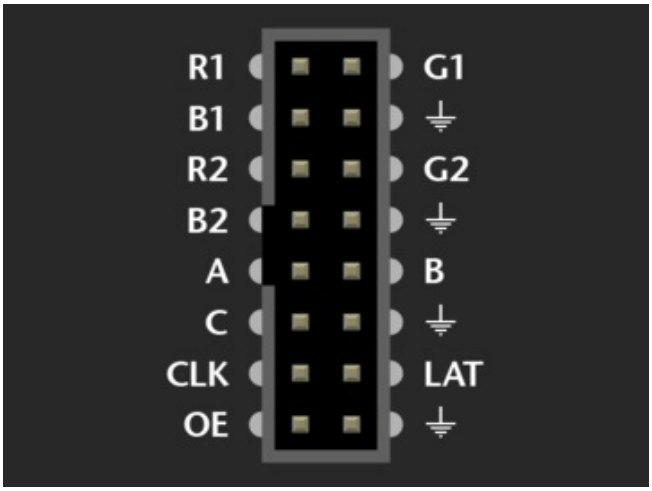
On some panels, if you're lucky, the sockets are labeled INPUT and OUTPUT (sometimes IN and OUT or similar), so it's obvious which is the input socket.

If INPUT is not labeled, look for one or more arrows pointing in the **horizontal** direction (ignore any vertical arrows, whether up or down). The horizontal arrows show the direction data moves from INPUT to OUTPUT — then you know which connector is which.

If no such labels are present, a last option is to examine the plastic shroud around the connector pins. The key (notch) on the INPUT connector will face the outer edge of the panel (not the center).

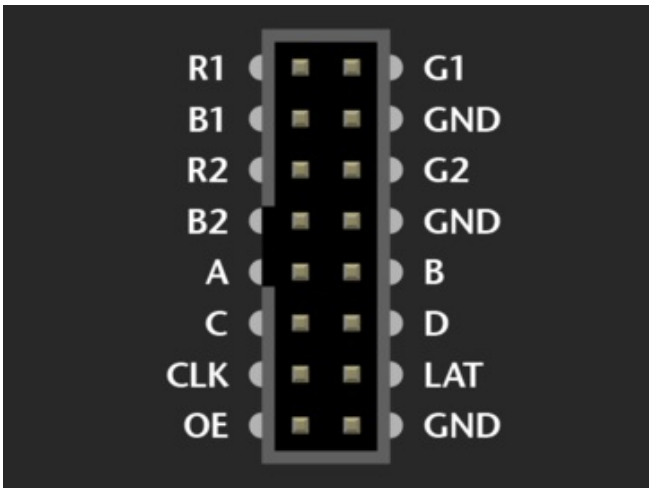


The arrangement of pins on the INPUT connector varies with matrix size and the batch in which it was produced…



A **32x16** panel uses this pin arrangement. The labels might be slightly different, or the pins might not be labeled at all…but in either case, use this image for reference.

Notice there are four ground connections. To ensure reliable performance, ***all four*** **should be connected to GND** on the Arduino! A solderless breadboard is handy for making this split.



Here's the layout for **32x32** and **64x32** panels. We'll call this "**Variant A**." Some panels use different labels, but the functions are identical.

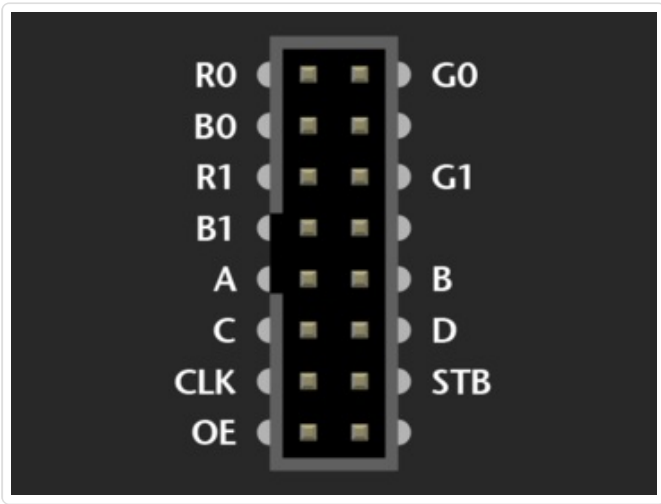
The layout is very similar to the 32x16 panel, with pin "D" replacing one ground connection.

This is the layout we'll be referencing most often.

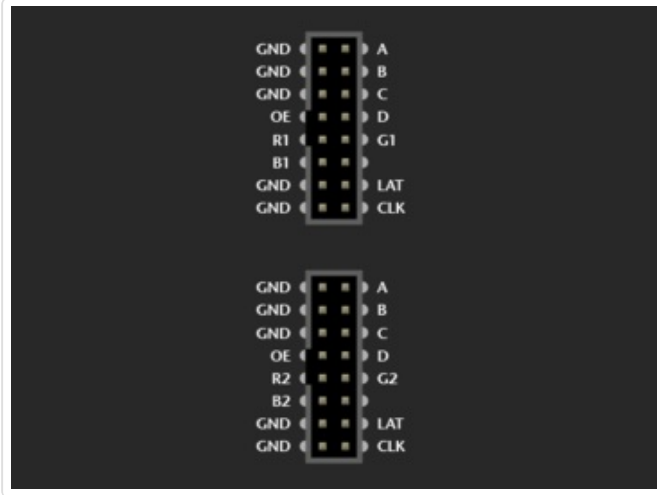
If you have a 32x32 panel with *no pin labels at all,* then use this layout.

"**Variant B**" for **32x32** and **64x32** panels. **The wiring is *identical* to Variant A above, *only the labels* are different.**

Ground pins aren't labeled, but still need to be connected.



LAT (latch) is labeled STB (strobe) here. R1/G1/B1/R2/G2/B2 are changed to R0/G0/B0/R1/G1/B1…but again, no functional difference, it's just ink.



Our earliest **32x32** panels had a **two-socket** design, let's call it "**Variant C**." All the same pin functions are present but the layout is very different.

R/G/B on the **upper** socket correspond to R1/G1/B1 in Variant A. R/G/B on the **lower** socket correspond to R2/G2/B2.

All the other signals (A/B/C/D/CLK/LAT/OE) need to be connected to **both** sockets — e.g. one pin on the Arduino drives both CLK pins, and so forth.

Connecting to Arduino

There are two methods for connecting a matrix to an Arduino:

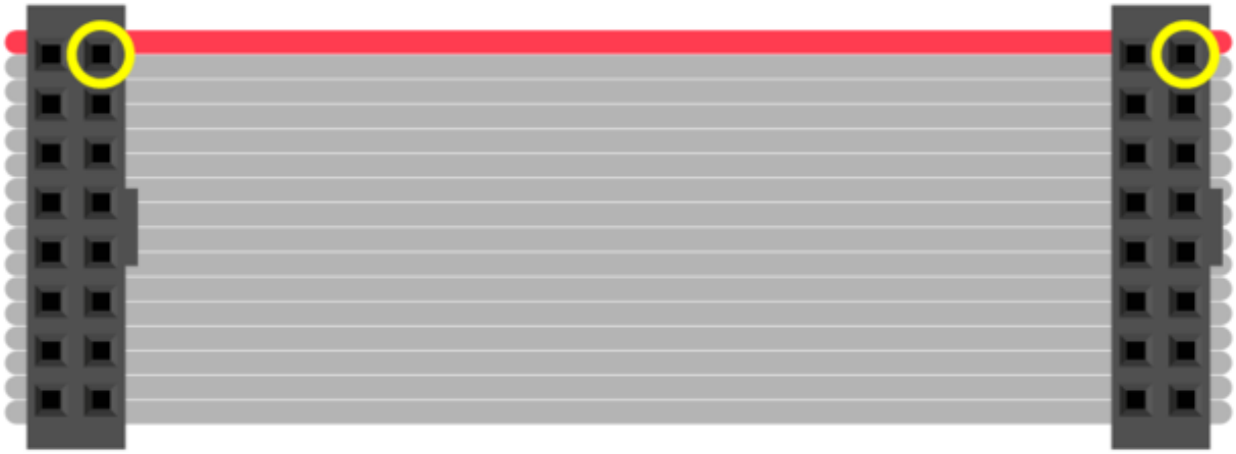
1. **Jumper wires** inserted between Arduino headers and a ribbon cable — this works well for testing and prototyping, but is not durable.
2. Building a ***proto shield*** — this is best for permanent installations.

These panels are normally run by very fast processors or FPGAs, not a 16 MHz Arduino. To achieve reasonable performance in this limited environment, our software is optimized by **tying specific signals to specific Arduino pins**. A *few* control lines can be reconfigured, but others are very specific…**you can't wire the whole thing willy-nilly.** The next two pages demonstrate compatible wiring…one using jumper wires, the other a proto shield…

Connecting with Jumper Wires

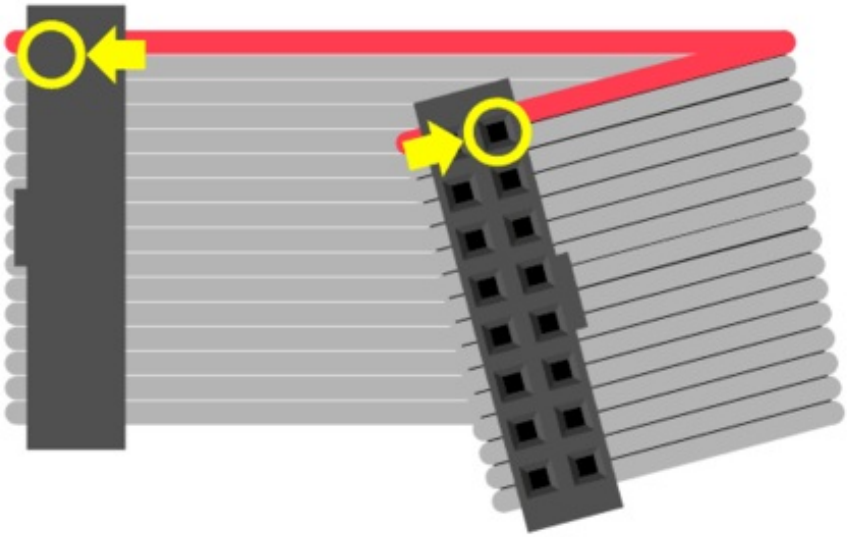
Ribbon cables and their corresponding headers are sometimes a topological puzzle. Here's a trick to help keep track…

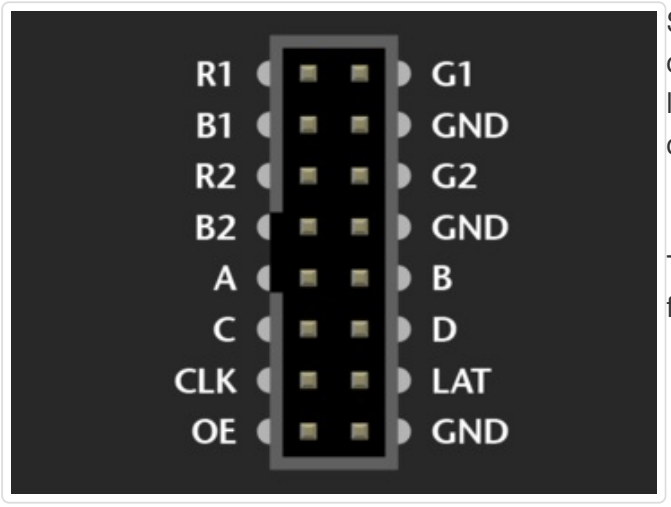
If you hold the ribbon cable flat — no folds — and with both connectors facing you, keys pointed the same direction — now there is a 1:1 correlation between the pins. The top-right pin on one plug links to the top-right on the other plug, and so forth. This holds true even if the cable has a doubled-over strain relief. **As long as the keys point the same way and the plugs face the same way, pins are in the same positions at both ends.**



Plugged into a socket on the LED matrix, one header now faces *away* from you. If you double the cable back on itself (not a twist, but a fold)…to access a specific pin on the socket, the left and right columns are now mirrored (rows are in the same order — the red stripe provides a point of reference). You're looking "up" into the plug rather than "down" into the socket.

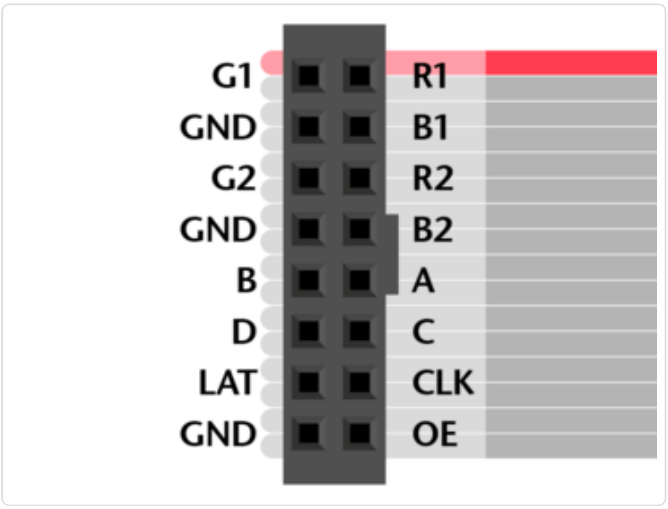
For example, R1 (the top-left pin on the INPUT socket) appears at the top-*right* of the exposed plug. You can jam a wire jumper in that hole to a corresponding pin on the Arduino…





So! From the prior page, refer to the socket that's correct for your matrix type. The labels may be a little different (or none at all), but most are pretty close to what's shown here.

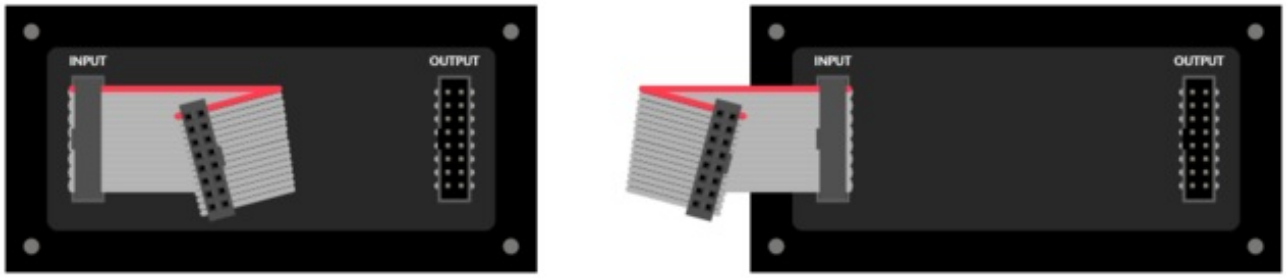
Then *swap the columns* to find the correct position for a given signal.



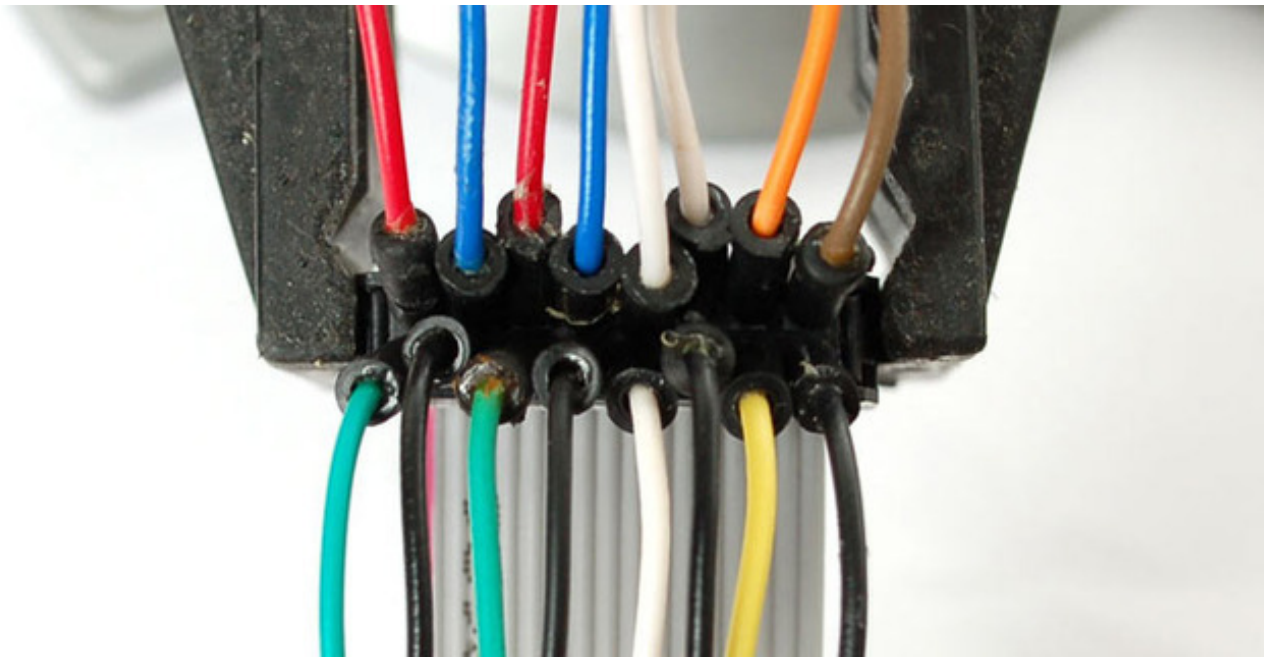
Either end of the ribbon cable can be plugged into the matrix INPUT socket. Notice below, the "key" faces the same way regardless.

With the free end of the ribbon toward the center of the matrix, the Arduino can be hidden behind it.

With the free end of the ribbon off the side, it's easier to see both the front of the matrix and the Arduino simultaneously, for making additional connections or for troubleshooting.



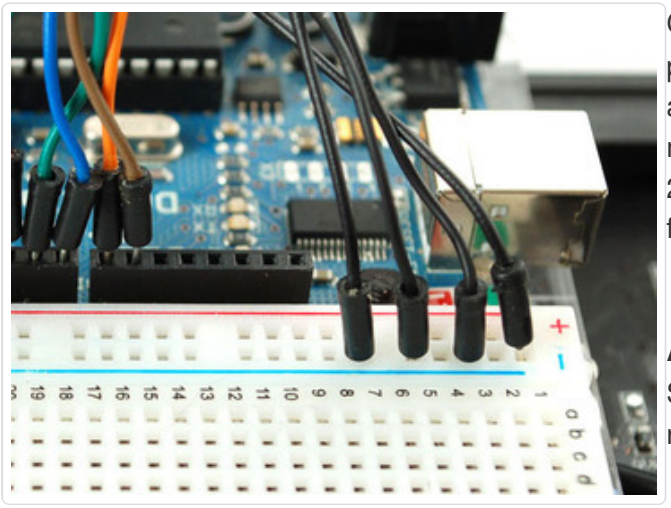
Using color-coded wires helps a *lot!* If you don't have colored wires, that's okay, just pay close attention where everything goes. Our goal is a fully-populated plug like this:



So! Let's proceed with the wiring, in groups…

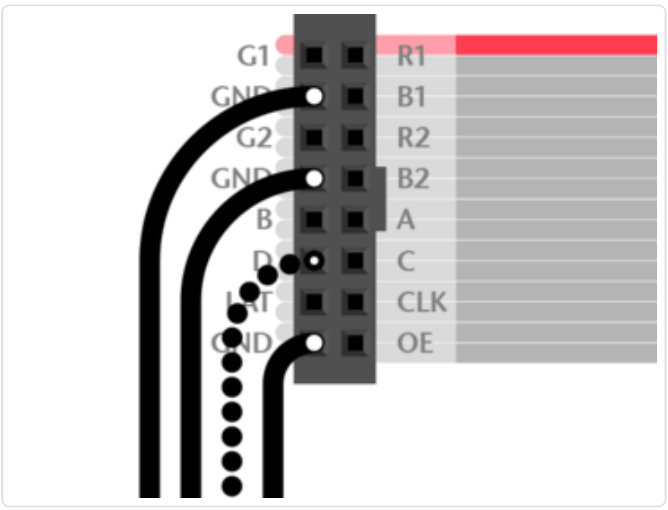
Connect Ground Wires

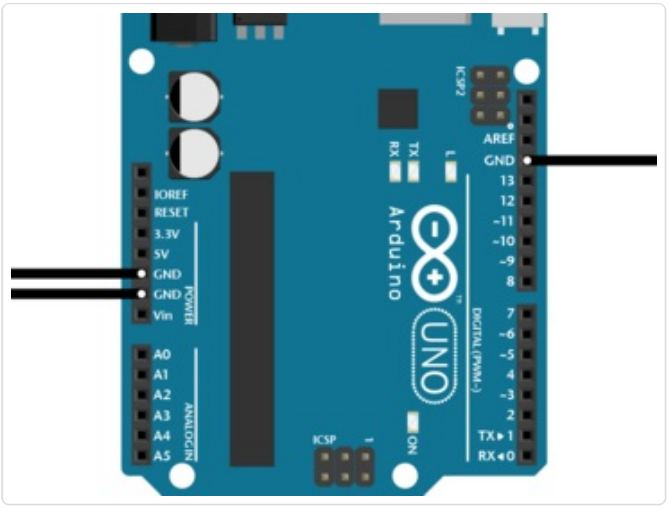
32x32 and **64x32** matrices require **three** ground connections. **32x16** matrices have **four**.

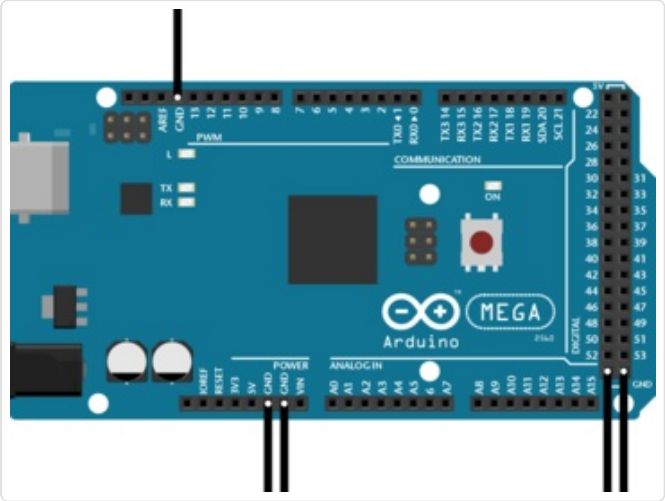


Current **Arduino Uno** boards have **three** ground pins (the third is next to pin 13). If you need additional ground connections — for a 32x16 matrix, or if using an older Arduino board with only 2 ground pins — a solderless breadboard is handy for linking all these pins.

Arduino Mega boards have **five** ground pins. Same three as the Arduino Uno, plus two more next to pins 52 & 53.





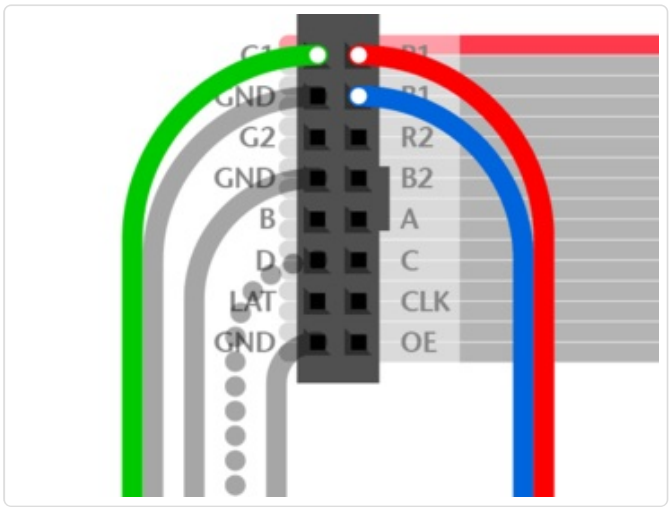


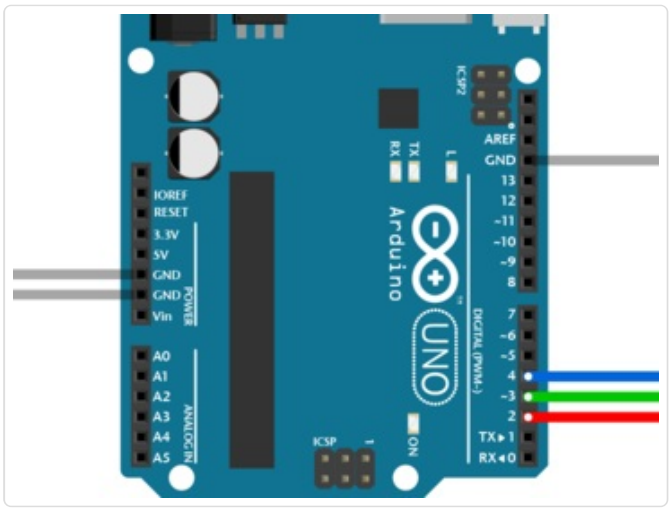
Upper RGB Data

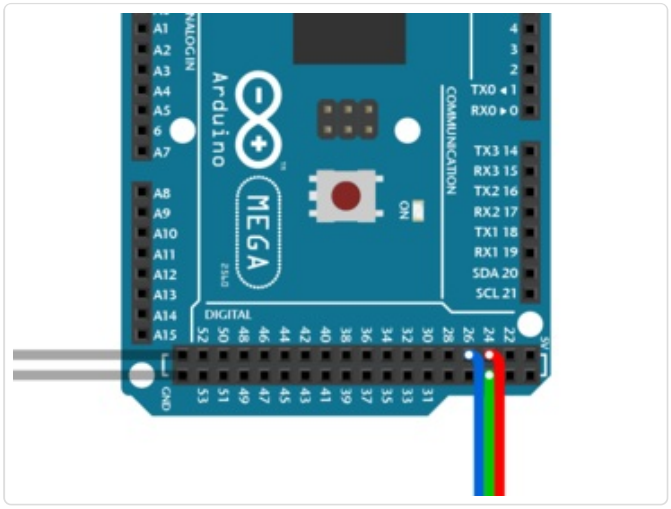
Pins **R1**, **G1** and **B1** (labeled R0, B0 and G0 on some matrices) deliver data to the **top half** of the display.

On the **Arduino Uno**, connect these to digital pins **2**, **3** and **4**.

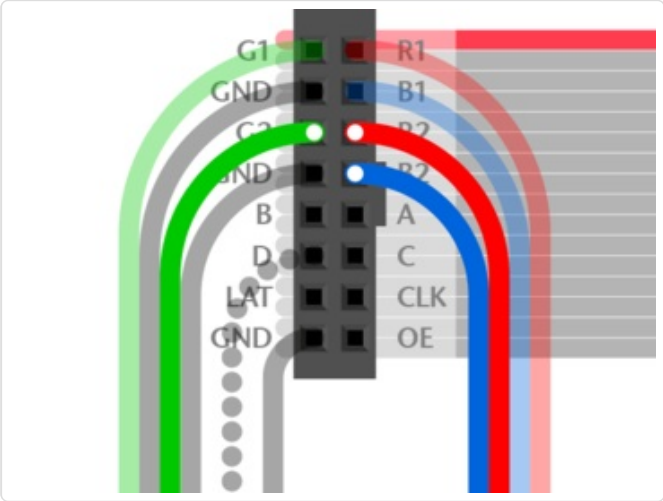
On **Arduino Mega**, connect to pins **24**, **25** and **26**.







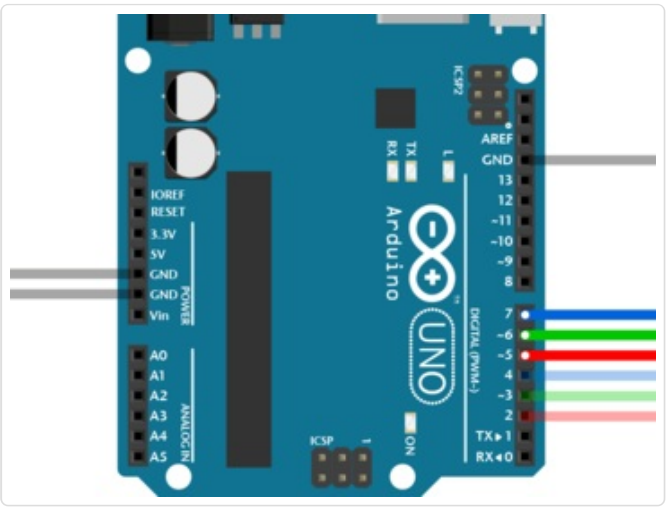
Lower RGB Data

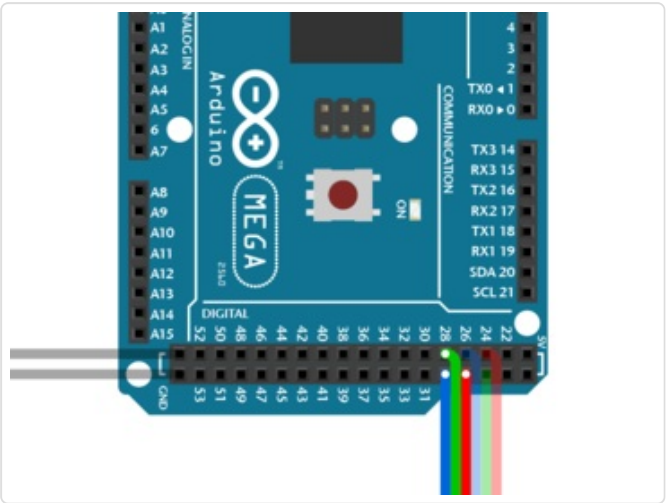


Pins **R2**, **G2** and **B2** (labeled R1, G1 and B1 on some matrices) deliver data to the **bottom half** of the display. These connect to the next three Arduino pins…

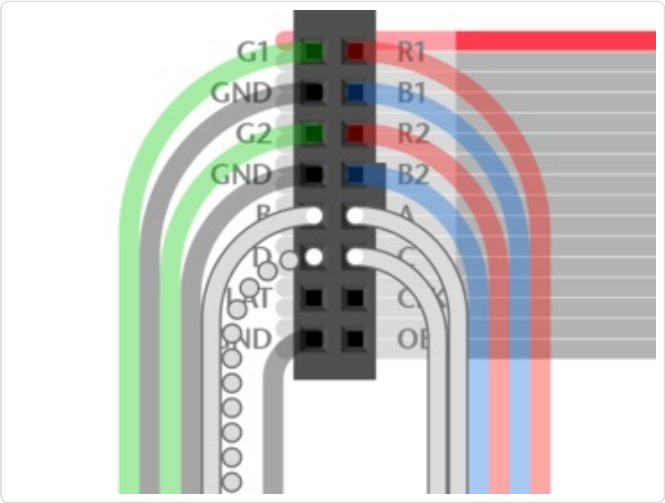
On **Arduino Uno**, that's pins **5**, **6** and **7**.

On **Arduino Mega**, pins **27**, **28** and **29**.



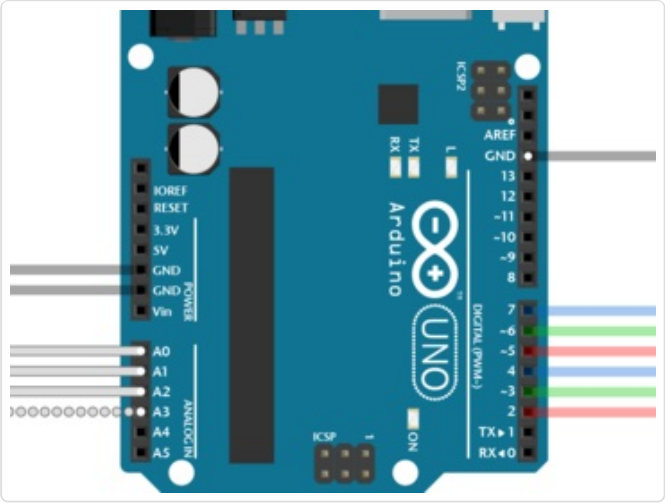


Row Select Lines



Pins **A**, **B**, **C** and **D** select which two rows of the display are currently lit. (**32x16 matrices don't have a "D" pin** — it's connected to **ground** instead.)

These connect to pins **A0**, **A1**, **A2** and (if D pin present) **A3**. This is the **same** for both the **Arduino Uno** and **Mega**.



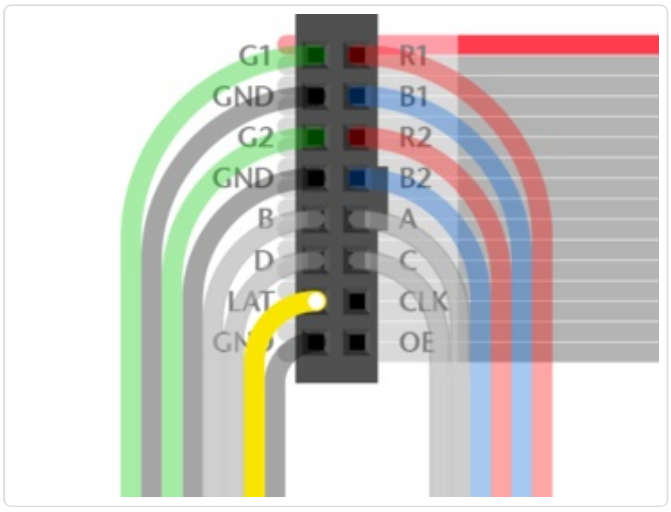
LAT Wire

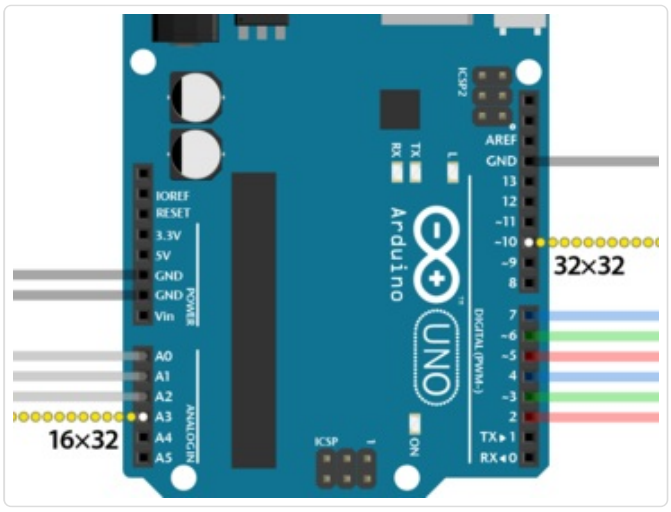
For **32x32** and **64x32** matrices, **LAT** connects to Arduino pin **10**.

For a **32x16** matrix, use Arduino pin **A3**.

This is the same for **Arduino Uno** or **Mega**.

The LAT (latch) signal marks the end of a row of data.

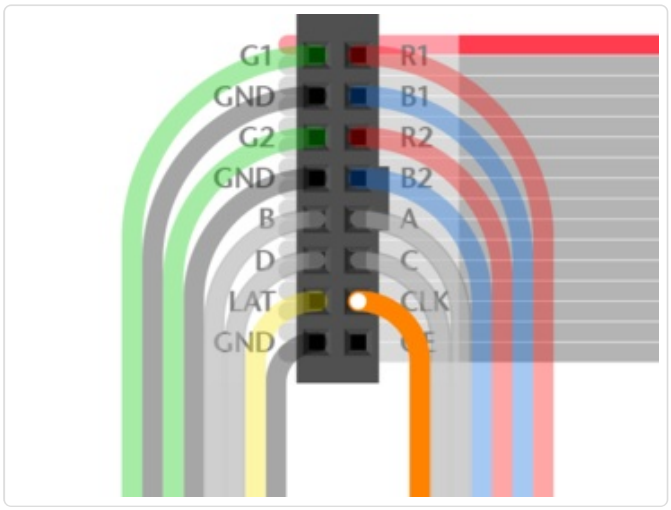


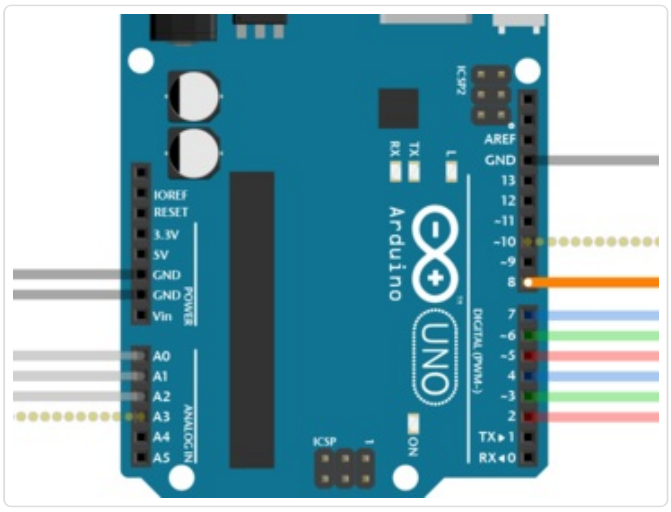


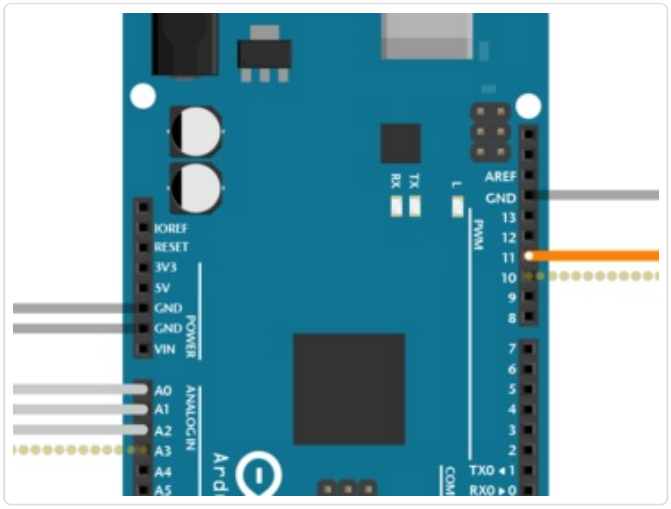
CLK Wire

CLK connects to **pin 8** on an **Arduino Uno**, or **pin 11** on an **Arduino Mega**.

The CLK (clock) signal marks the arrival of each bit of data.

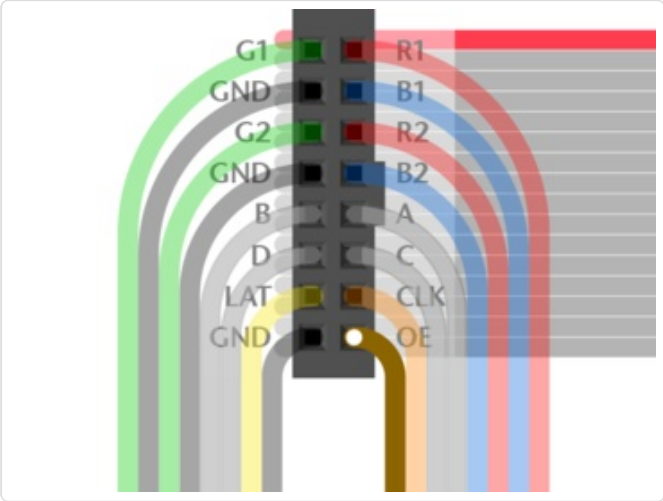

G1
R1
GND
B1
G2
R2
GND
B2
B
A
D
C
LAT
CLK
GND


ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
IOREF
RESET
3.3V
5V
GND
GND
Vin
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
ICSP
ON
Arduino
UNO
DIGITAL (PWM~)


AREF
GND
13
12
11
10
9
8
7
6
5
4
3
2
TX0◄1
RX0►0
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
PWM

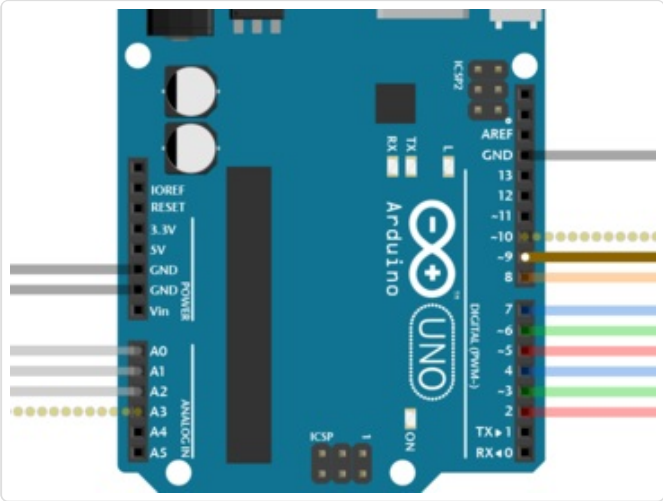
OE Wire

Last one!



OE connects to Arduino pin **9**. This is the same for both the **Arduino Uno** and **Mega**.

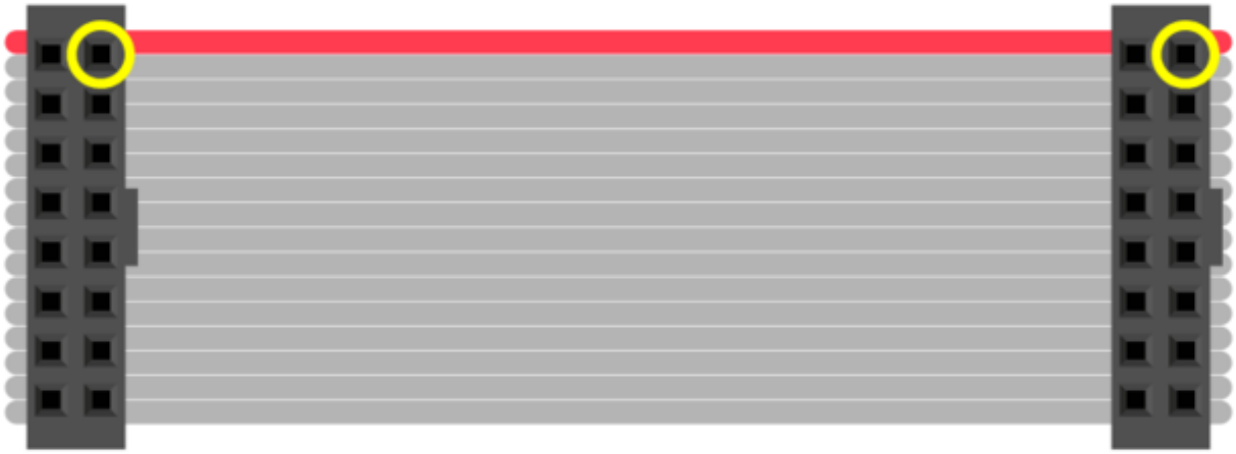
OE (output enable) switches the LEDs off when transitioning from one row to the next.



That's it. You can skip ahead to the "Test Example Code" page now.

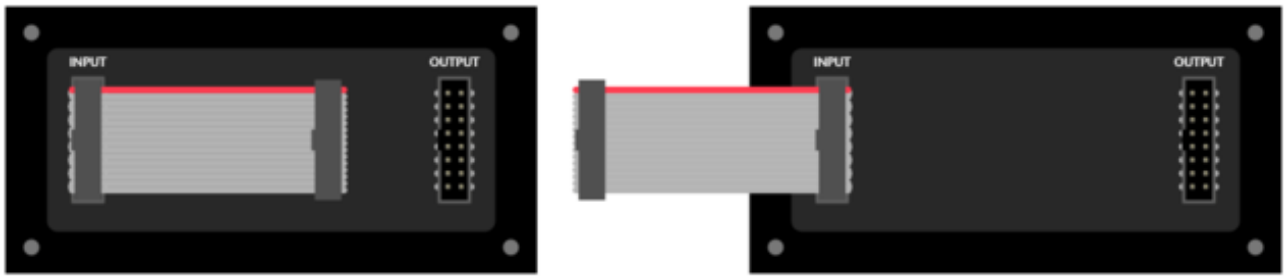
Connecting Using a Proto Shield

As mentioned on the “Jumper” page: if you hold a ribbon cable flat — no folds — and with both connectors facing you, keys pointed the same direction — there’s is a 1:1 correlation between the pins. The top-right pin on one plug links to the top-right on the other plug, and so forth. This holds true even if the cable has a doubled-over strain relief. **As long as the keys point the same way and the plugs face the same way, pins are in the same positions at both ends.**

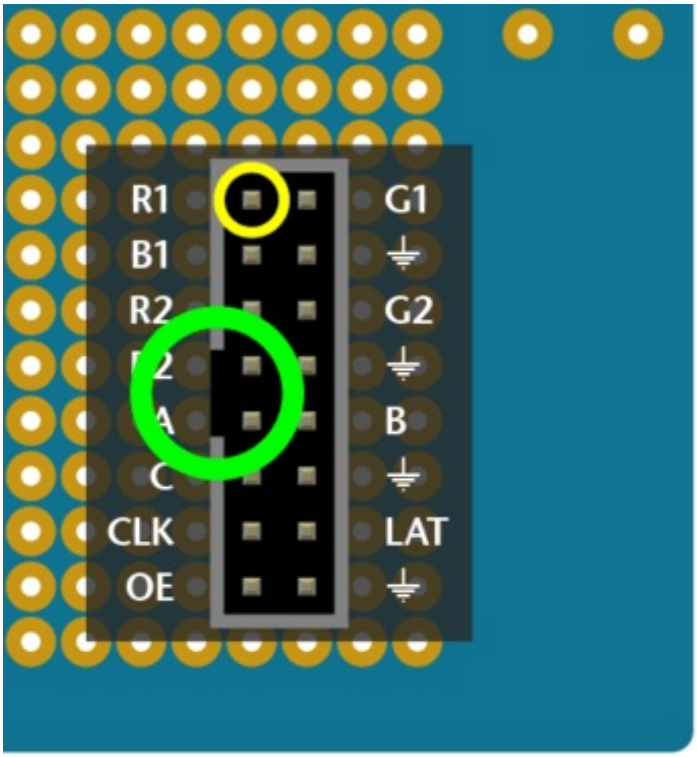


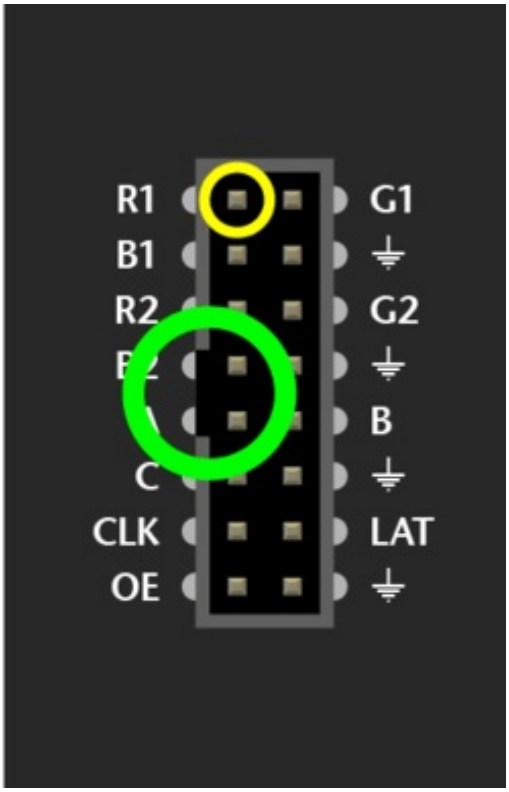
Either end of the ribbon cable can be plugged into the matrix INPUT socket.

The free end of the ribbon can point toward the center of the matrix, or hang off the side…the pinout is still the same. Notice below the direction of the “key” doesn’t change.



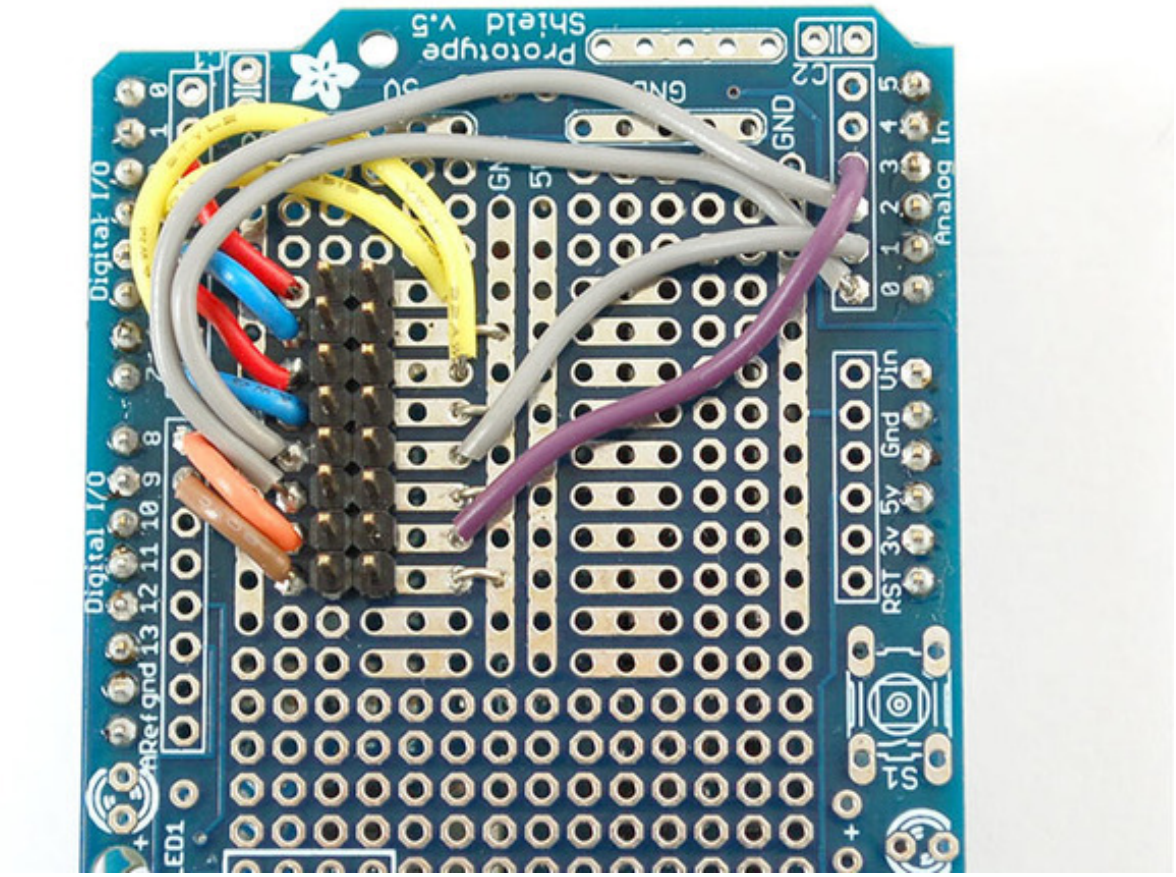
A dual-row header gets installed on the proto shield, similar to the connector on the matrix. Just like the ribbon cable lying flat, as long as these two headers are *aligned the same way,* they’ll **match pin-for-pin**; unlike the jumper wire method from the prior page, mirroring doesn’t happen.





Wires are then soldered from the header to specific Arduino pins on the proto shield. Try to keep wire lengths reasonably short to avoid signal interference.

Using color-coded wires helps a *lot!* If you don't have colored wires, that's okay, just pay close attention where everything goes. Our goal is a proto shield something like this:



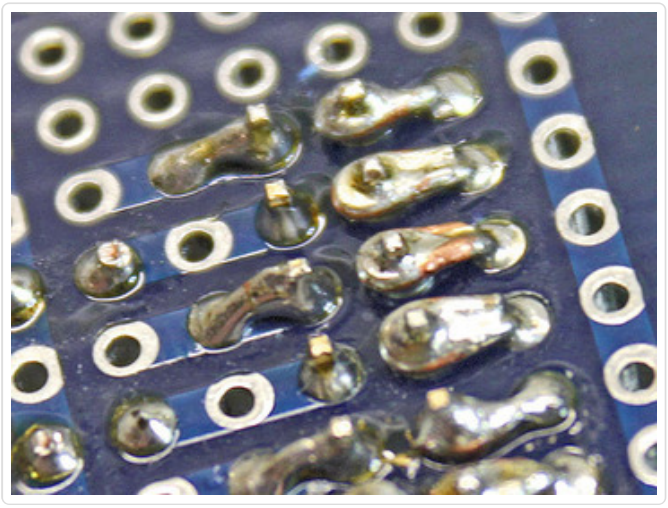
It's not necessary to install all the buttons and lights on the proto shield if you don't want — just the basic header pins are sufficient.

For **Arduino Uno**, using an **Adafruit** proto shield (http://adafru.it/eUM): **if using a shrouded socket (like on the back of the matrix — with the notch so a ribbon cable only fits one way) you'll need to place this near the "Reset" end of the shield.** The plastic shroud obscures a lot of pins. **Others' proto shields may be laid out different**…look around for a good location before committing to solder.

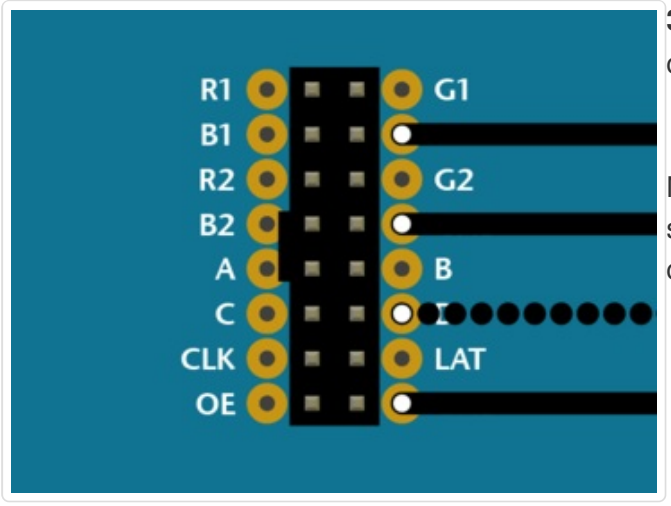
For **Arduino Mega** with our corresponding proto shield (http://adafru.it/192): a shrouded socket fits best near the **middle** of the shield.

Otherwise, you can use a plain 2x8-pin male header, or two 1x8 sections installed side-by-side (as in the photo above). Since there's no alignment key with this setup, you might want to indicate it with some tape or a permanent marker.

Depending on the make and model of proto shield, some pins are designed to connect in short rows. Others don't. For the latter, strip a little extra insulation and bend the wire to wrap around the leg of the socket from behind, then solder.



Connect Ground Wires



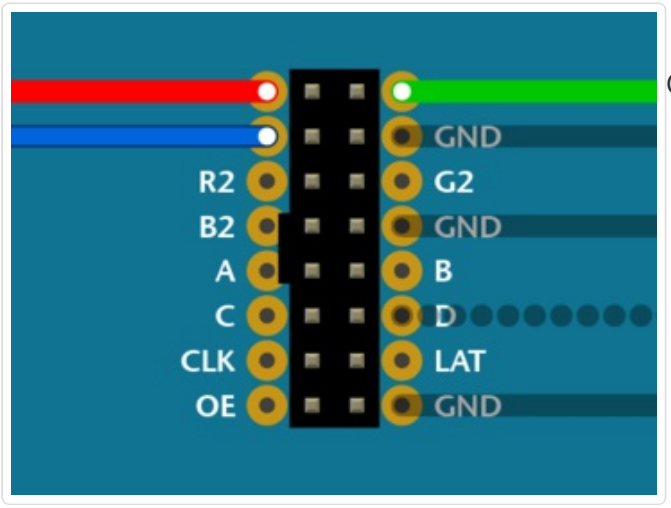
32x32 and **64x32** matrices require **three** ground connections. **32x16** matrices have **four**.

Most proto shields have *tons* of grounding points, so you shouldn't have trouble finding places to connect these.

Upper RGB Data

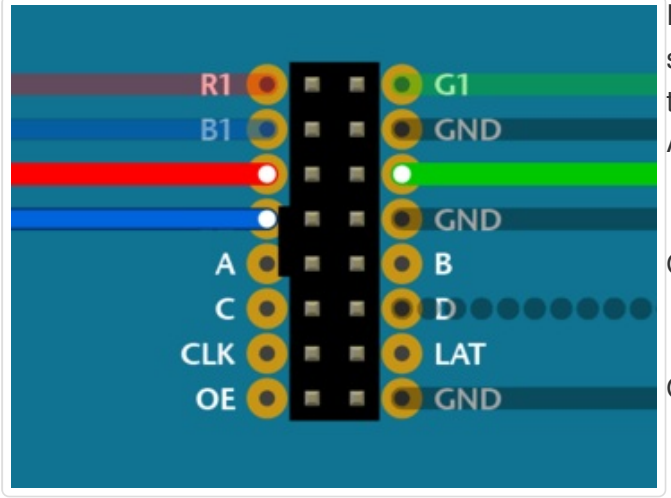
Pins **R1**, **G1** and **B1** (labeled R0, B0 and G0 on some matrices) deliver data to the **top half** of the display.

On the **Arduino Uno**, connect these to digital pins **2**, **3** and **4**.



On **Arduino Mega**, connect to pins **24**, **25** and **26**.

Lower RGB Data



Pins **R2**, **G2** and **B2** (labeled R1, G1 and B1 on some matrices) deliver data to the **bottom half** of the display. These connect to the next three Arduino pins…

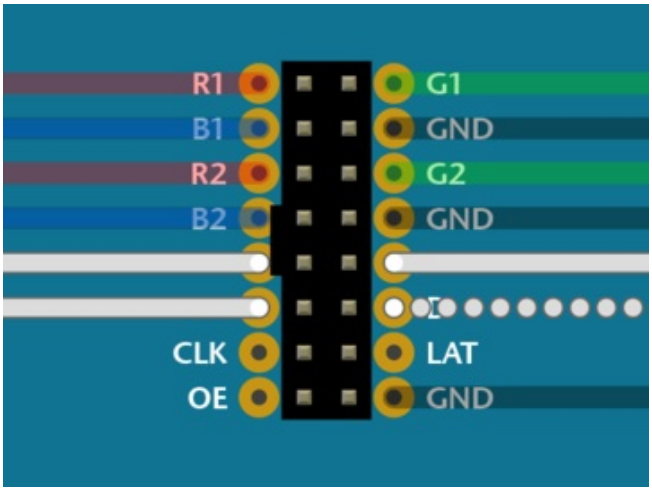
On **Arduino Uno**, that's pins **5**, **6** and **7**.

On **Arduino Mega**, pins **27**, **28** and **29**.

Row Select Lines

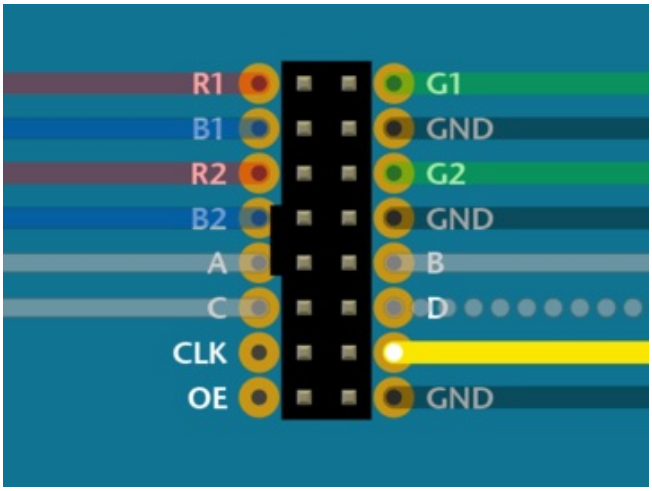
Pins **A**, **B**, **C** and **D** select which two rows of the display are currently lit. (**32x16 matrices don't have a "D" pin** — it's connected to **ground** instead.)

These connect to pins **A0**, **A1**, **A2** and (if D pin present) **A3**. This is the **same** for both the **Arduino**



Uno and **Mega**.

LAT Wire



For **32x32** and **64x32** matrices, **LAT** connects to Arduino pin **10**.

For a **32x16** matrix, use Arduino pin **A3**.

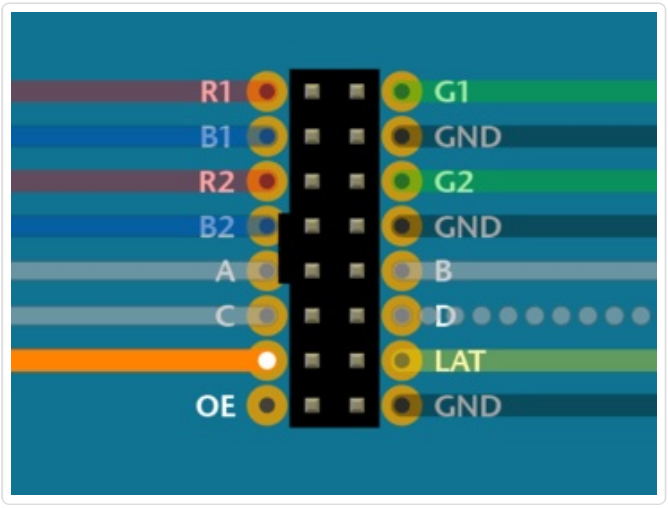
This is the same for **Arduino Uno** or **Mega**.

The LAT (latch) signal marks the end of a row of data.

CLK Wire

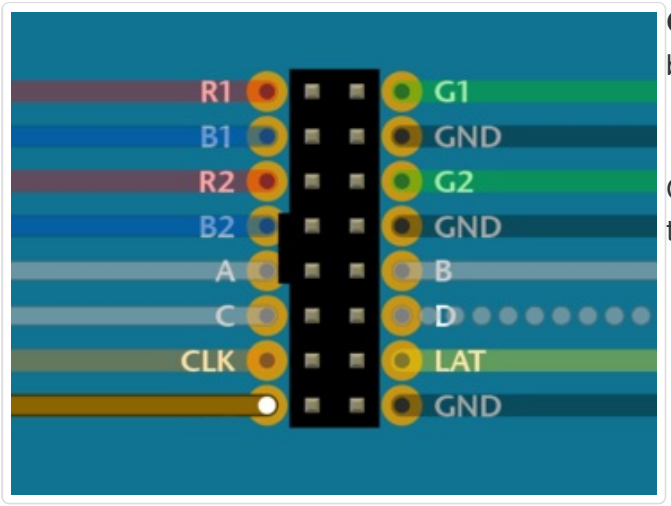
CLK connects to **pin 8** on an **Arduino Uno**, or **pin 11** on an **Arduino Mega**.

The CLK (clock) signal marks the arrival of each bit of data.



OE Wire

Last one!



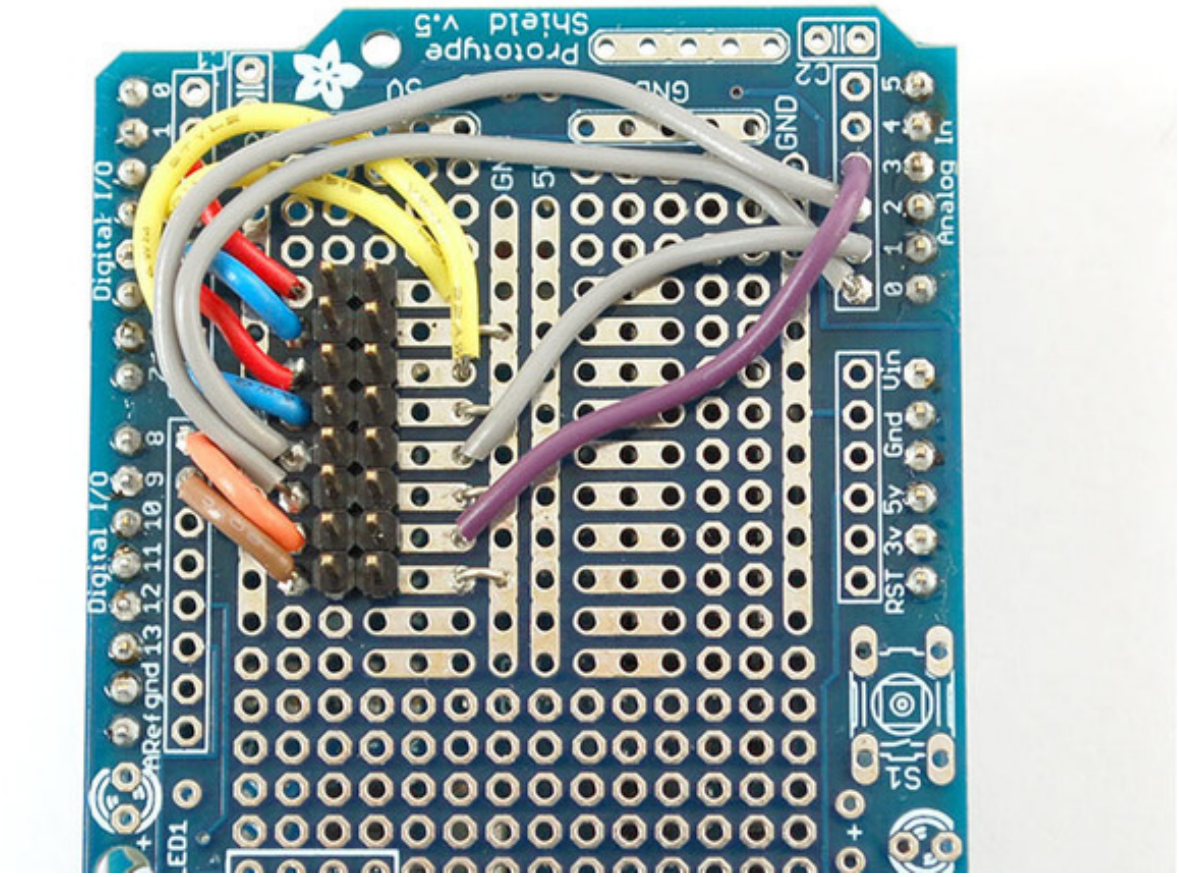
OE connects to Arduino pin **9**. This is the same for both the **Arduino Uno** and **Mega**.

OE (output enable) switches the LEDs off when transitioning from one row to the next.

Here's that photo again of a completed shield. You can tell this is for a 32x16 matrix, because there are four ground connections (one of the long vertical strips is a ground bus — see the tiny jumpers there?).

The ribbon cable to the matrix would plug into this with the key facing left.

The colors don't quite match the examples above, but are close. G1 and G2 are yellow wires. LAT is the purple wire.


Prototype Shield v.5
Digital I/O
Digital I/O
Analog In
GND
Vin
Gnd
5v
3v
RST
AREF gnd 13 12 11 10 9 8

Test Example Code

We have example code ready to go for these displays. It's compatible with the Arduino Uno or Mega…but ***not*** other boards like the Leonardo, nor "Arduino-like" boards such as Netduino… programming gurus *might* be able to port it to other microcontrollers by adapting the C++ source, but as written it does some pretty low-level, non-portable things.

> The library works ONLY with the Arduino Uno and Mega. Other boards (such as the Arduino Leonardo) ARE NOT SUPPORTED.

Two libraries need to be downloaded and installed: first is the RGB Matrix Panel library (http://adafru.it/aHj) (this contains the low-level code specific to this device), and second is the Adafruit GFX Library (http://adafru.it/aJa) (which handles graphics operations common to many displays we carry). Download both ZIP files, uncompress and rename the folders to 'RGBmatrixPanel' and 'Adafruit_GFX' respectively, place them inside your Arduino libraries folder and restart the Arduino IDE. If this is all unfamiliar, we have a tutorial introducing Arduino library concepts and installation (http://adafru.it/aYG).

Now you are ready to test! Open up the IDE and load
File→Examples→RGBmatrixPanel→testcolors_16x32 (for the 16x32 panel) or
File→Examples→RGBmatrixPanel→colorwheel_32x32 (for the 32x32 panel).

If you are using the 32x32 panel, before you upload this code to the Arduino, edit the pin definitions to match the specific wiring used by your panel (single- or double-header interface). Comments in the file will direct you to what needs changed (if anything).

If using an Arduino Mega 2560, in addition to wiring changes previously mentioned, you'll need to make a small change to each of the example sketches. This line:

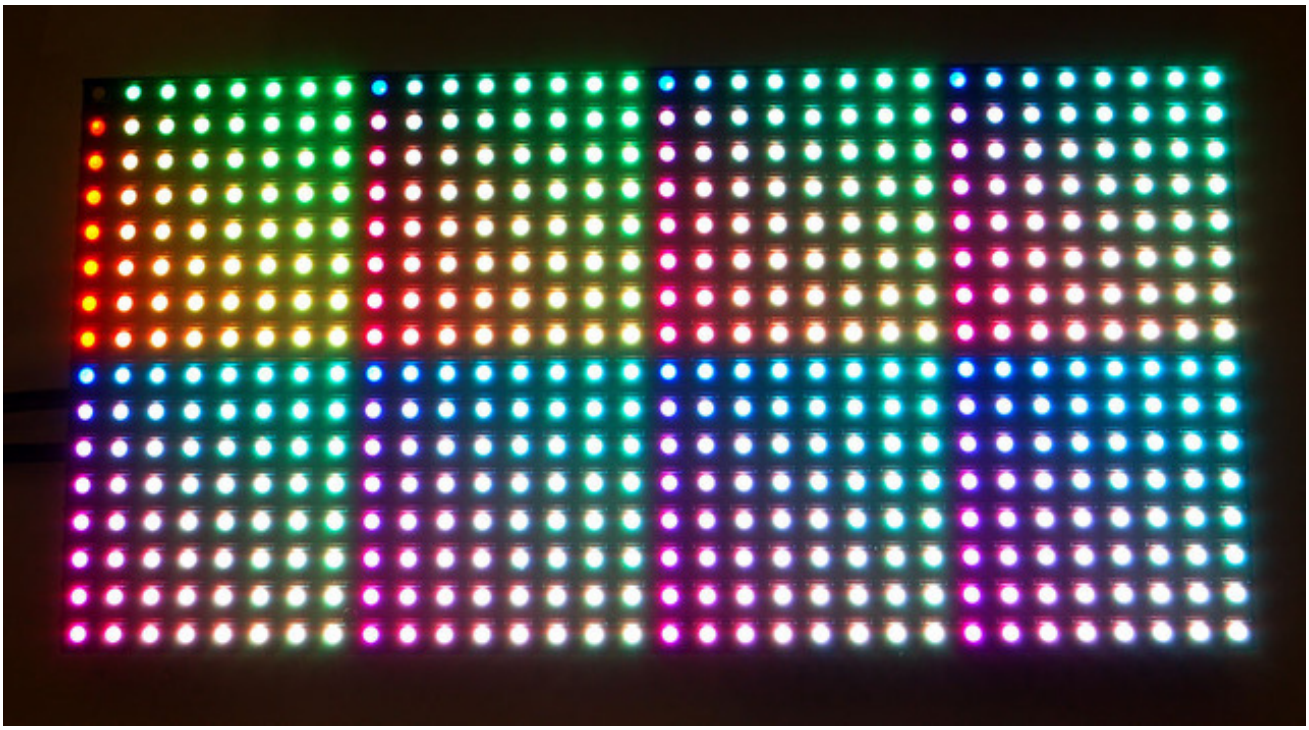
```
#define CLK 8  // MUST be on PORTB! (Use pin 11 on Mega)
```

Should be changed to:

```
#define CLK 11
```

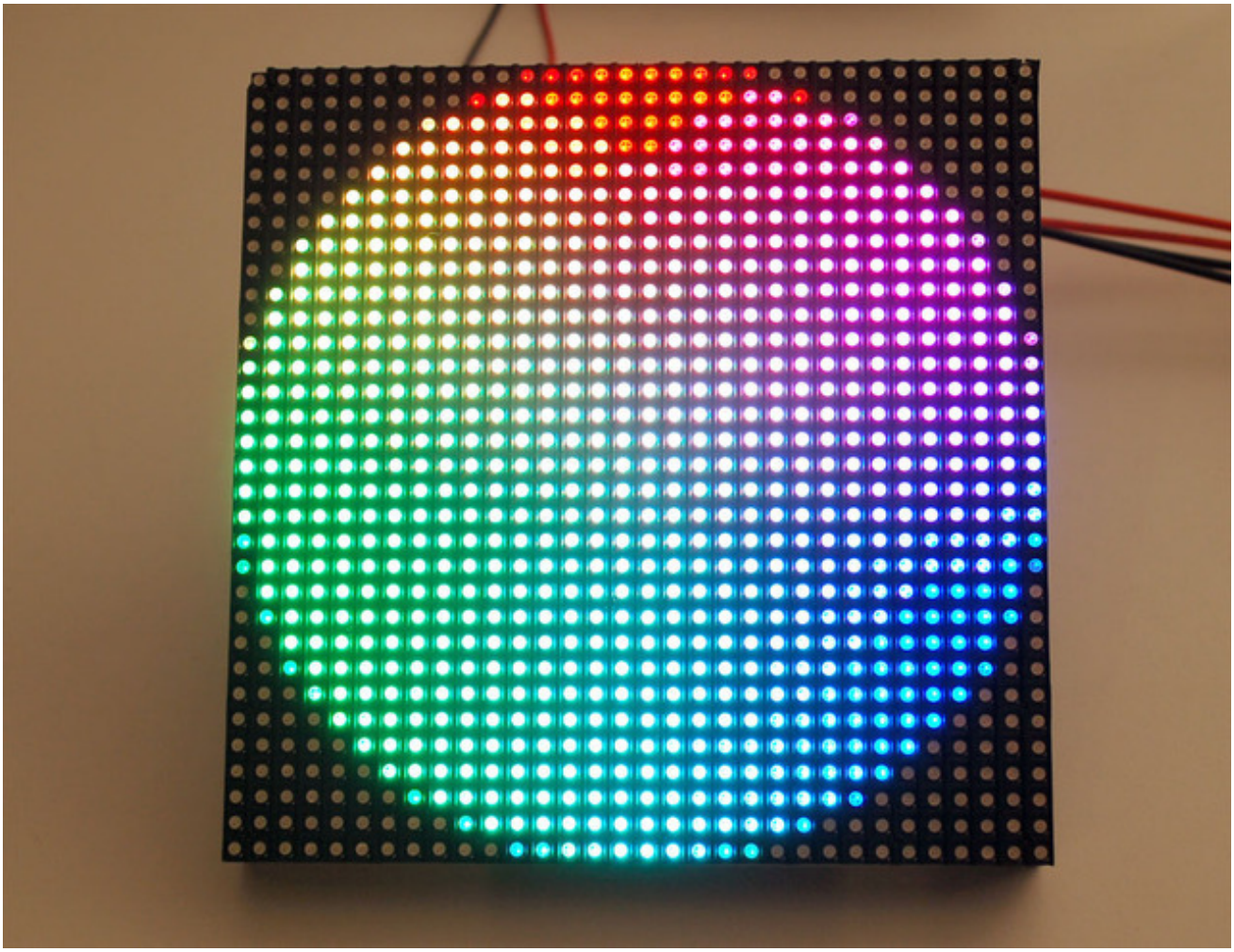
(Any of digital pins 10-13 and 50-53 can be used for this function on the Mega, with the corresponding wiring change. The examples all reference pin 11, as pin 10 may be in use for the 32x32 panel.)

After uploading, with the 16x32 panel you should see the following:



This is a test pattern that shows 512 colors (out of 4096) on the 512 pixels. Since there's no really elegant way to show a 3-dimensional color space (R/G/B) in two dimensions, there's just repeating grids of red/green with increasing blue. Anyways, this shows you the range of colors you can achieve!

or, with the 32x32 panel:



Now that you've got it working here are a few things to look for:

The most useful line to look at is:

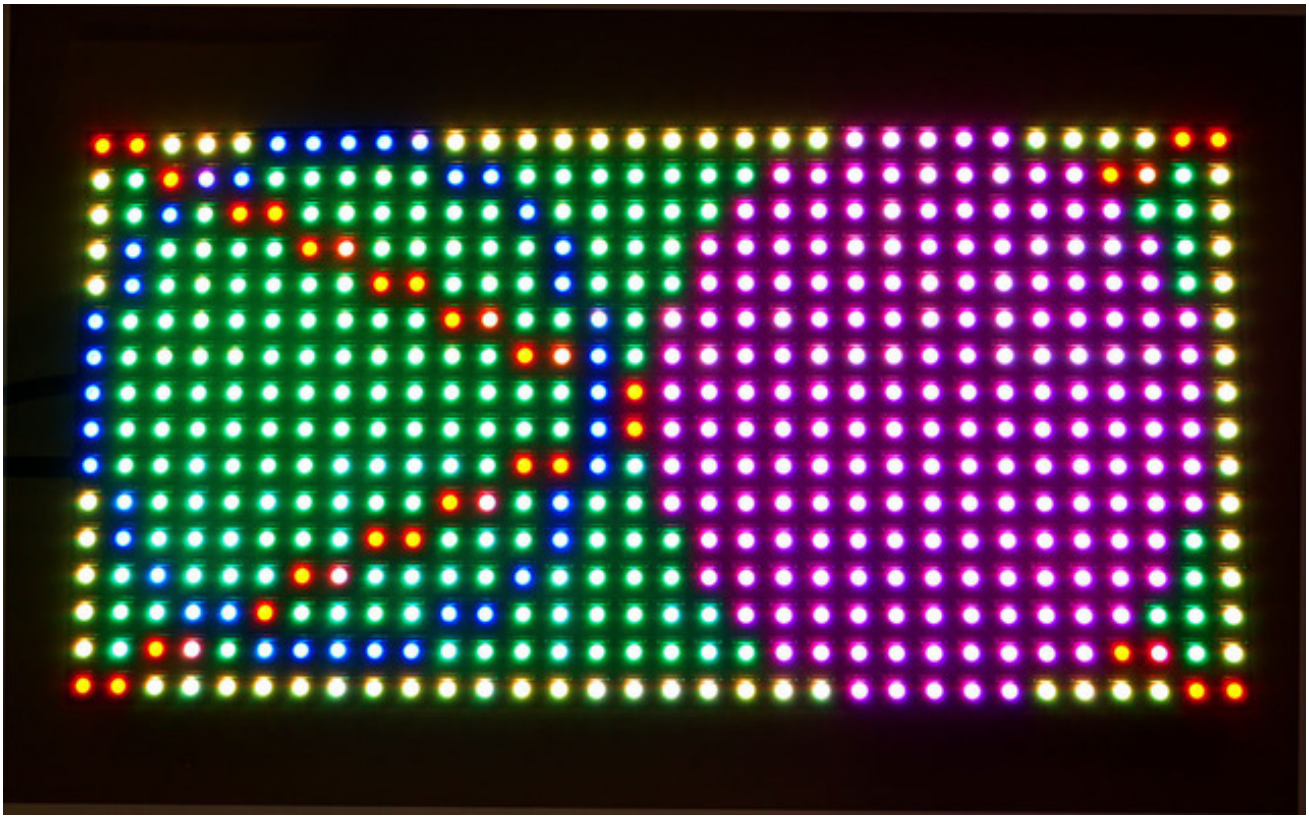
```
matrix.drawPixel(x, y, matrix.Color333(r, g, b));
```

which is where we actually draw to the display. This code only draws one pixel at a time. The **x** and **y** coordinates are the individual pixels of the display. **(0,0)** is in the top left corner, **(31, 15)** is in the bottom right (remember that we start counting at 0 here!). To create a color, you will want to use the helper funciton **Color333** which will take three 3-bit numbers and combine them into a single packed integer. So for example, the first argument, **r** can range from 0 to 7. Likewise for **g**and **b**. To make a pixel that is pure red, **r** would be 7 and **g, b** would be 0. To make a white pixel, set all to 7. To make a black (off) pixel, set the colors to 0. A similar function, **Color444**, accepts three 4-bit numbers for up to 4096 colors.

Now we can open up the next example, which shows the rest of the library capabilities.

Library

Next up, load the **testshapes_16x32** or **testshapes_32x32** example sketch, which will test every drawing element available (again, you may need to edit the pin numbers for the 32x32 panel).



The most simple thing you may want to do is draw a single pixel, we saw this introduced above.

```
// draw a pixel in solid white
matrix.drawPixel(0, 0, matrix.Color333(7, 7, 7));
```

Next we will fill the screen with green by drawing a really large rectangle. The first two arguments are the top left point, then the width in pixels, and the height in pixels, finally the color

```
// fix the screen with green
matrix.fillRect(0, 0, 32, 16, matrix.Color333(0, 7, 0));
```

Next we will draw just the outline of a rectangle, in yellow

```
// draw a box in yellow
matrix.drawRect(0, 0, 32, 16, matrix.Color333(7, 7, 0));
```

Next you may want to draw lines. The **drawLine** procedure will draw a line in any color you want, we used this to draw a big X

```
// draw an 'X' in red
matrix.drawLine(0, 0, 31, 15, matrix.Color333(7, 0, 0));
matrix.drawLine(31, 0, 0, 15, matrix.Color333(7, 0, 0));
```

The next shapes we draw are circles. You can draw the outline of a circle with **drawCircle** or fill a circle with **fillCircle**. The first two arguments are the center point, the third argument is the radius in pixels, finally the color to use.

```
// draw a blue circle
matrix.drawCircle(7, 7, 7, matrix.Color333(0, 0, 7));

// fill a violet circle
matrix.fillCircle(23, 7, 7, matrix.Color333(7, 0, 7));
```

fill allows you to fill the entire screen with a single color

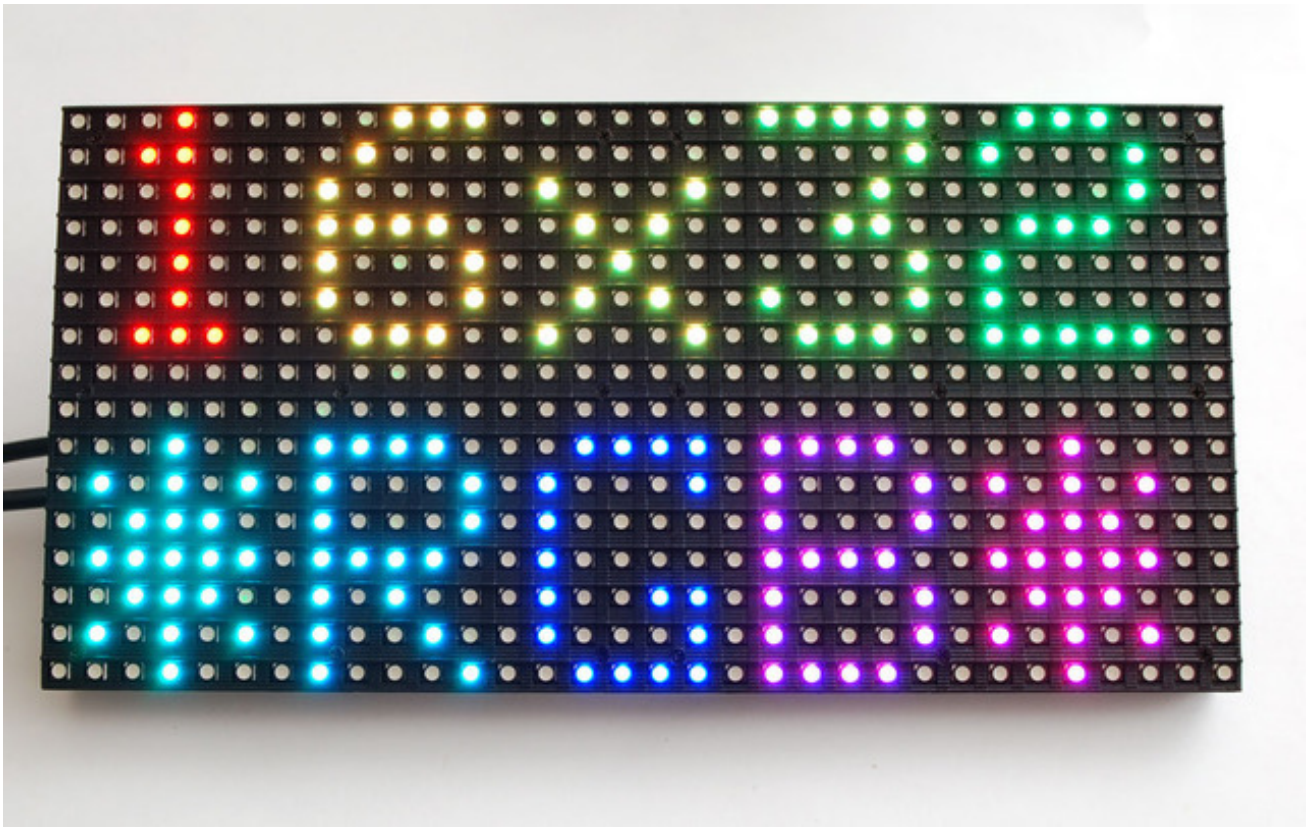
```
// fill the screen with 'black'
matrix.fill(matrix.Color333(0, 0, 0));
```

Finally, we draw the text that is shown up top as the demonstration image. We can use the **print** function, which you'll be familiar with from **Serial**. You can use **print** to print strings, numbers, variables, etc. However, we need to set up the printing before just going off and doing it! First, we must set the cursor location with **setCursor** which is where the top left pixel of the first character will go, this can be anywhere but note that text characters are 8 pixels high by default. Next **setTextSize** lets you set the size to 1 (8 pixel high) or 2 (16 pixel high for really big text!), you probably want just to stick with 1 for now. Lastly we can set the color of the text with **setTextColor**. Once this is all done, we can just use**print('1')** to print the character "1".

```
// draw some text!
matrix.setCursor(1, 0);   // start at top left, with one pixel of spacing
matrix.setTextSize(1);    // size 1 == 8 pixels high

// print each letter with a rainbow color
matrix.setTextColor(matrix.Color333(7,0,0));
matrix.print('1');
matrix.setTextColor(matrix.Color333(7,4,0));
matrix.print('6');
matrix.setTextColor(matrix.Color333(7,7,0));
matrix.print('x');
matrix.setTextColor(matrix.Color333(4,7,0));
matrix.print('3');
matrix.setTextColor(matrix.Color333(0,7,0));
matrix.print('2');

matrix.setCursor(1, 9);   // next line
matrix.setTextColor(matrix.Color333(0,7,7));
matrix.print('*');
matrix.setTextColor(matrix.Color333(0,4,7));
matrix.print('R');
matrix.setTextColor(matrix.Color333(0,0,7));
matrix.print('G');
matrix.setTextColor(matrix.Color333(4,0,7));
matrix.print("B");
matrix.setTextColor(matrix.Color333(7,0,4));
matrix.print("*");
```



How the Matrix Works

There's zero documention out there on how these matrices work, and no public datasheets or spec sheets so we are going to try to document how they work.

First thing to notice is that there are 512 RGB LEDs in a 16x32 matrix. Like pretty much every matrix out there, **you can't drive all 512 at once**. One reason is that would require a lot of current, another reason is that it would be really expensive to have so many pins. Instead, the matrix is divided into 8 interleaved sections/strips. The first section is the 1st 'line' and the 9th 'line' (32 x 2 RGB LEDs = 64 RGB LEDs), the second is the 2nd and 10th line, etc until the last section which is the 7th and 16th line. You might be asking, why are the lines paired this way? wouldnt it be nicer to have the first section be the 1st and 2nd line, then 3rd and 4th, until the 15th and 16th? The reason they do it this way is so that the lines are interleaved and look better when refreshed, otherwise we'd see the stripes more clearly.

So, on the PCB is 12 LED driver chips. These are like 74HC595s but they have 16 outputs and they are constant current. 16 outputs * 12 chips = 192 LEDs that can be controlled at once, and 64 * 3 (R G and B) = 192. So now the design comes together: You have 192 outputs that can control one line at a time, with each of 192 R, G and B LEDs either on or off. The controller (say an FPGA or microcontroller) selects which section to currently draw (using A, B, and C address pins - 3 bits can have 8 values). Once the address is set, the controller clocks out 192 bits of data (24 bytes) and latches it. Then it increments the address and clocks out another 192 bits, etc until it gets to address #7, then it sets the address back to #0

The only downside of this technique is that despite being very simple and fast, it has **no PWM control** built in! The controller can **only** set the LEDs **on or off**. So what do you do when you want full color? You actually need to draw the entire matrix over and over again at very high speeds to PWM the matrix manually. For that reason, you need to have a very fast controller (50 MHz is a minimum) if you want to do a lot of colors and motion video and have it look good.

How quickly can we feed data to the matrix? Forum users Andrew Silverman and Ryan Brown have been posting their progress (http://adafru.it/aO2) driving the 16x32 matrix with an FPGA, and the limit appears to be somewhere between 40 and 50 MHz. Ryan writes: “I haven't validated 100% pixel correctness, but 50 MHz seems to work for me […] 67MHz definitely did not work.” He also provided this graph showing current draw relative to clock frequency:

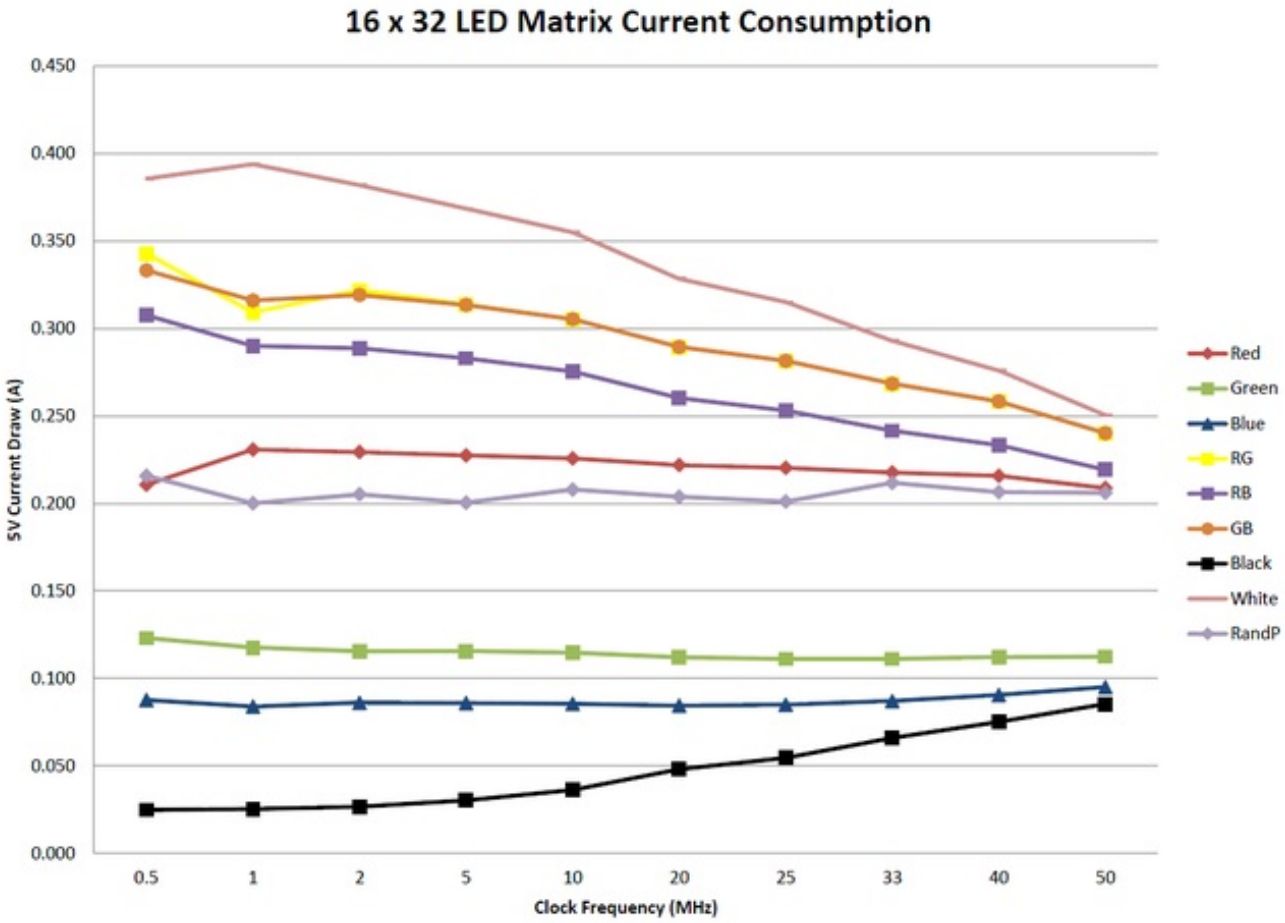


Image above by rhb.me (CC By-NC-SA)

“Notice that the LED panel current consumption decreases as clock frequency increases. This suggests that the LED ‘on time’ is decreasing. I’m guessing this is caused by frequency-invariant delays in the LED driver shift registers.”

Downloads

Download our RGBmatrixPanel library (http://adafru.it/aHj) by clicking the **ZIP** button near the top left corner, rename the uncompressed folder **RGBmatrixPanel**. Check that the **RGBmatrixPanel** folder contains **RGBmatrixPanel.cpp** and**RGBmatrixPanel.h**. Similarly, download the Adafruit_GFX library here (http://adafru.it/aJa) . Rename the uncompressed folder **Adafruit_GFX** and confirm it contains **Adafruit_GFX.cpp** and **Adafruit_GFX.h**. Place both library folders inside your**<arduinosketchfolder>/libraries/** folder. You may need to create the libraries subfolder if its your first library. Restart the IDE.