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Adafruit NeoPixel Überguide

Created by Phillip Burgess



Last updated on 2017-02-01 06:37:04 PM UTC

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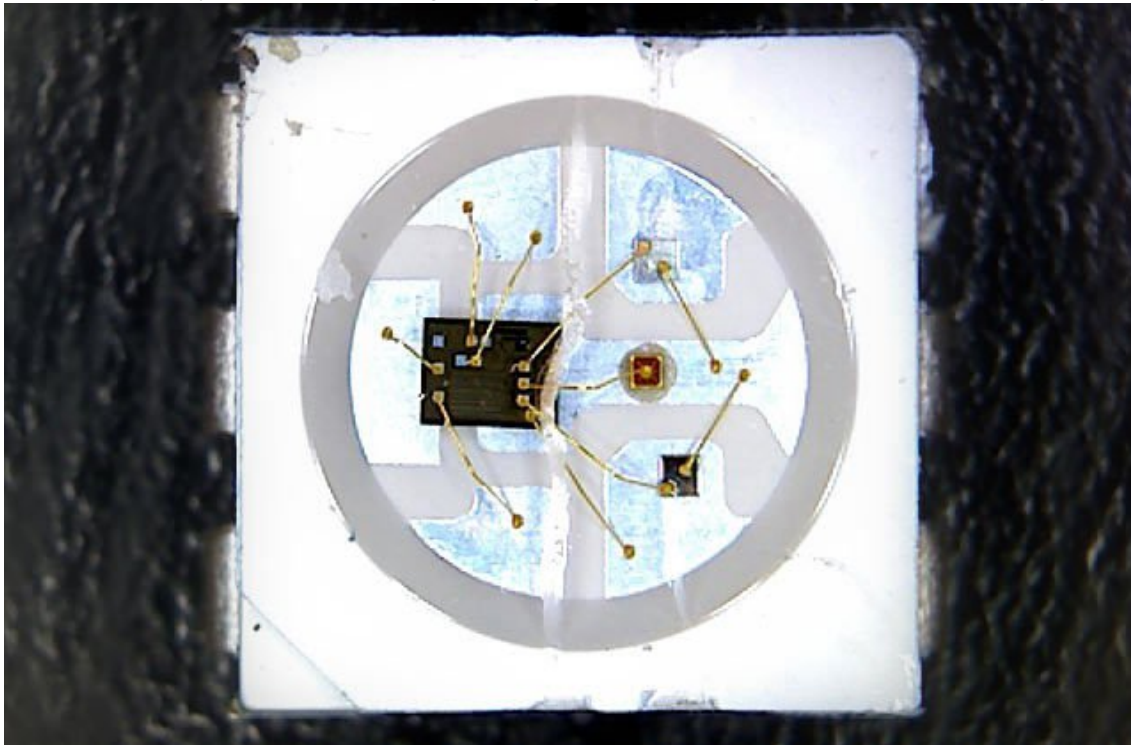
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The Magic of NeoPixels

Incorporating scads of LEDs into an electronic project used to be a hairy prospect, a veritable rat's nest of wires and code. The arrival of dedicated LED driver chips brought welcome relief, offloading grunt work from the microcontroller and allowing one to focus on the application. Much simpler, but still not "Christmas light" simple.

The **WS2812** Integrated Light Source — or **NeoPixel** in Adafruit parlance — is the latest advance in the quest for a simple, scalable and affordable full-color LED. Red, green and blue LEDs are integrated alongside a driver chip into a tiny surface-mount package controlled through a single wire. They can be used individually, chained into longer strings or assembled into still more interesting form-factors.



We know you're eager to get started...but If this is your first time using NeoPixels, please at least read the "Best Practices" page before connecting anything!

Important Things to Know About NeoPixels in General

- **Not all addressable LEDs are NeoPixels.** "NeoPixel" is Adafruit's brand for individually-addressable RGB color pixels and strips based on the **WS2812**, **WS2811** and **SK6812** LED/drivers, using a single-wire control protocol. Other LED products we carry — DotStars, WS2801 pixels, LPD8806 and "analog" strips — use different methodologies (and have their own tutorials). *When seeking technical support in the forums, a solution can be found more quickly if the correct LED type is mentioned, i.e. avoid calling DotStars "NeoPixels"...similar, but different!*
- NeoPixels don't just light up on their own; **they require a microcontroller** (such as Arduino) and some programming. We provide some sample code to get you started. To create your own effects and animation, you'll need some programming practice. If this is a new experience, work through

some of the beginning Arduino tutorials to get a feel for the language.

- **NeoPixels aren't the answer for every project.** The control signal has very strict timing requirements, and some development boards (such as Netduino or Raspberry Pi) can't reliably achieve this. This is why we continue to offer other LED types; some are more adaptable to certain situations.

Can I use NeoPixels for POV (persistence of vision) displays?

Not recommended. The refresh rate is relatively low (about 400 Hz), and color displays in fast motion may appear "speckled." They look fine in stationary displays though (signs, decorations, jewelry, etc.). For POV use, [DotStar strips](http://adafru.it/kDg) (<http://adafru.it/kDg>) will look much better (they have about a 20 KHz refresh rate).

How about for light painting?

Definitely! The slower movement used for photographic light painting doesn't call attention to the limited refresh rate; [the results look great](http://adafru.it/jTb) (<http://adafru.it/jTb>), especially with a light diffuser.

Is there a limit to the number of NeoPixels in a chain?

There's no *inherent* limit in the maximum length of a NeoPixel chain, but eventually you'll encounter any of various *practical* limits:

1. **RAM:** NeoPixels require some RAM from the host microcontroller; more pixels = more RAM. It's only a few bytes each, but as most microcontrollers are pretty resource-constrained, this becomes a very real consideration for large projects.
2. **Power:** each NeoPixel draws a little bit of current; more pixels = more power. Power supplies likewise have some upper limit.
3. **Time:** NeoPixels process data from the host microcontroller at a fixed data rate; more pixels = more time and lower animation frame rates.

Form Factors



NeoPixel products are available in *azillion* form factors...from individual tiny pixels to huge matrices...plus strips, rings and everything in-between.

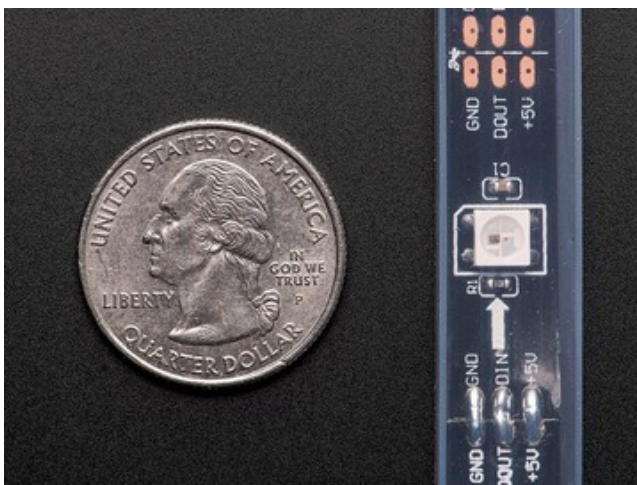
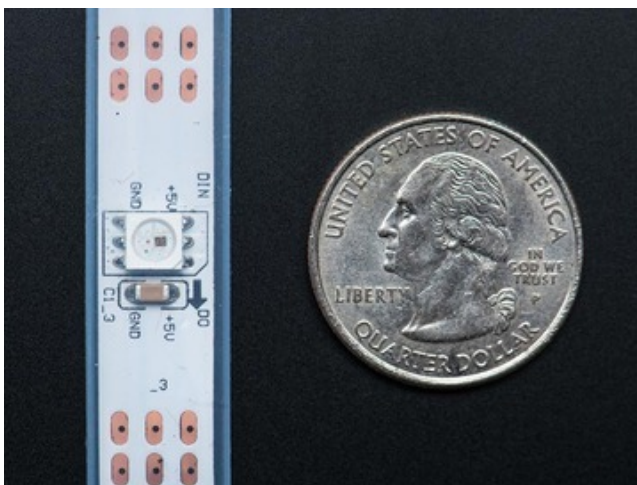
Pick a category from the left column for product links and tips & tricks specific to each type of NeoPixel.

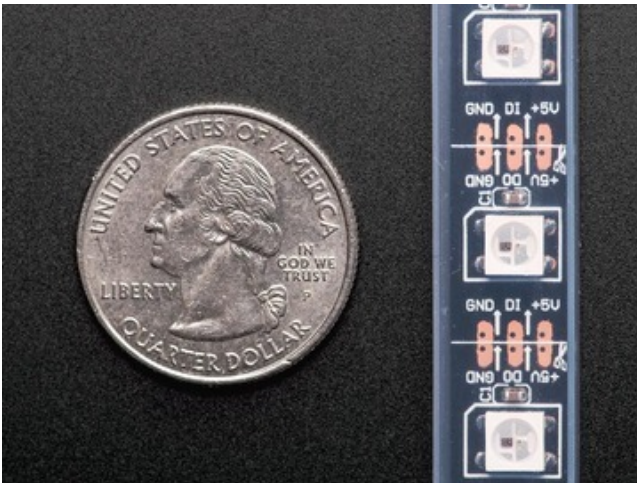
NeoPixel Strips

The most popular type of NeoPixels are these **flexible LED strips**...they can be cut to length and fit into all manner of things. We've got a *dozen* varieties! Two **vital** things to be aware of:

- Though strips are described as “flexible,” **they do not tolerate continuous and repeated bending**. “Formable” might be a better word. A typical application is architecture, where they can be curved around columns and then stay put. Repeated flexing (as on costumes) will soon crack the solder connections. For wearable use, either affix shorter segments to a semi-rigid base (e.g. a hat, BMX armor, etc.), or use the individual *sewable* NeoPixels shown later.
- Watch your power draw. Though each pixel only needs a little current, it **adds up fast**...NeoPixel strips are so simple to use, one can quickly get carried away! We'll explain more on the “Powering NeoPixels” page.

RGB NeoPixel Strips





NeoPixel Digital RGB LED Weatherproof Strip is available in three different “densities”: 30, 60 and 144 LEDs per meter, on a white or black backing strip.

- [30 LEDs per meter, white strip](http://adafru.it/1376) (<http://adafru.it/1376>)
- [30 LEDs per meter, black strip](http://adafru.it/1460) (<http://adafru.it/1460>)
- [60 LEDs per meter, white strip](http://adafru.it/1138) (<http://adafru.it/1138>)
- [60 LEDs per meter, black strip](http://adafru.it/1461) (<http://adafru.it/1461>)
- [144 LEDs per meter, white strip](http://adafru.it/1507) (<http://adafru.it/1507>)
- [144 LEDs per meter, black strip](http://adafru.it/1506) (<http://adafru.it/1506>)

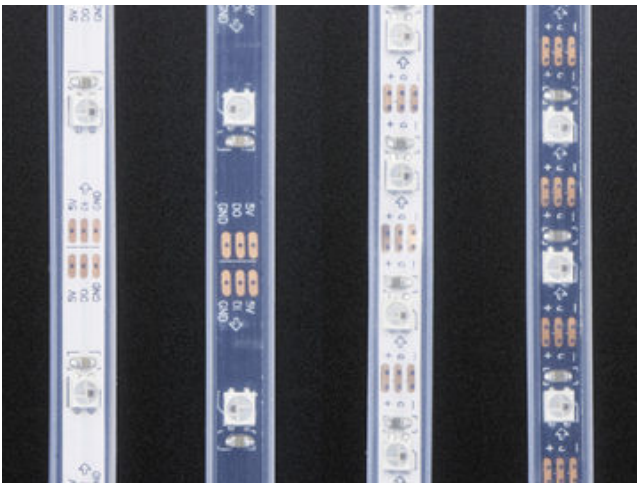
The *approximate* peak power use (all LEDs on at maximum brightness) per meter is:

- **30 LEDs:** 9 Watts (about 1.8 Amps at 5 Volts).
- **60 LEDs:** 18 Watts (about 3.6 Amps at 5 Volts).
- **144 LEDs :** 43 watts (8.6 Amps at 5 Volts).

Mixed colors and lower brightness settings will use proportionally less power.

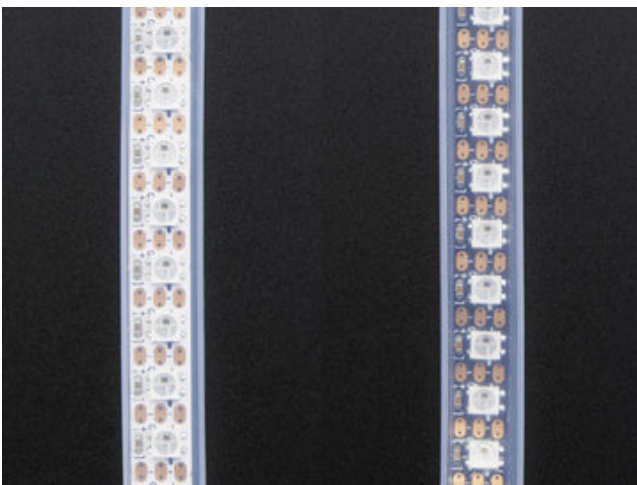


Mini Skinny RGB NeoPixel Strips



Mini Skinny NeoPixel strips are about **half** the width of classic NeoPixel strips. They're available in two densities and backing colors:

- [30 LEDs per meter, white strip \(http://adafru.it/2949\)](http://adafru.it/2949)
- [30 LEDs per meter, black strip \(http://adafru.it/2954\)](http://adafru.it/2954)
- [60 LEDs per meter, white strip \(http://adafru.it/IFs\)](http://adafru.it/IFs)
- [60 LEDs per meter, black strip \(http://adafru.it/2964\)](http://adafru.it/2964)
- [144 LEDs per meter, white strip \(http://adafru.it/IXa\)](http://adafru.it/IXa)
- [144 LEDs per meter, black strip \(http://adafru.it/IXb\)](http://adafru.it/IXb)



30 and 60 LED/meter strips are 7.5 mm wide, or 5 mm if you remove the strip from the casing (vs 12.5 mm / 10 mm for classic strips). The high-density 144/m strips are about 10 mm wide, or 7.5mm with the casing removed.

Power requirements are similar to standard-width NeoPixel strips as described above.

RGBW NeoPixel Strips

A recent addition is **RGBW** NeoPixel strips. These add a fourth LED element — pure white — which is more “true” and pleasing to the eye than white mixed from red+green+blue. Like the RGB strips, they’re available in different pixel densities and backing strip colors.



- [30 RGBW LEDs per meter, white strip \(http://adafru.it/2832\)](http://adafru.it/2832)
- [30 RGBW LEDs per meter, black strip \(http://adafru.it/2824\)](http://adafru.it/2824)
- [60 RGBW LEDs per meter, white strip \(http://adafru.it/2842\)](http://adafru.it/2842)
- [60 RGBW LEDs per meter, black strip \(http://adafru.it/2837\)](http://adafru.it/2837)
- [144 RGBW LEDs per meter, white strip \(http://adafru.it/2847\)](http://adafru.it/2847)
- [144 RGBW LEDs per meter, black strip \(http://adafru.it/2848\)](http://adafru.it/2848)

With a fourth LED per pixel, these strips may potentially draw up to 33% more current than their RGB equivalents. The maximum brightest cases are (approximately):

- **30 RGBW LEDs:** 12 Watts (2.4 Amps at 5 Volts)
- **60 RGBW LEDs:** 24 Watts (4.8 Amps at 5 Volts)
- **144 RGBW LEDs:** 57 Watts (11.5 Amps at 5 Volts)

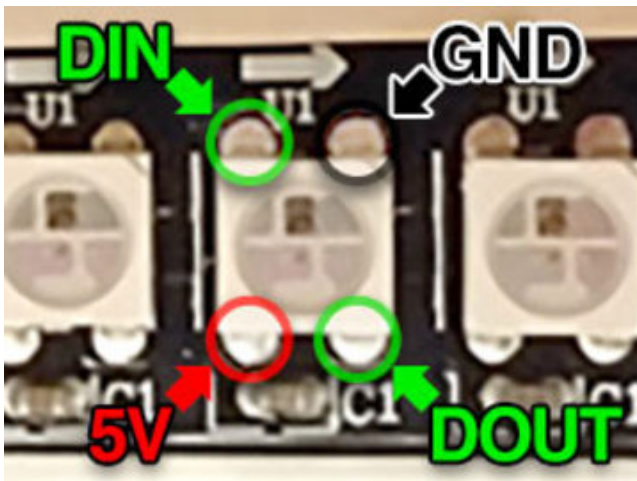
Width is the same as “classic” NeoPixel strip... these are *not* the “skinny” size.

Finer Details About NeoPixel Strips

- **144 pixel/m** NeoPixel strips are sold in **one meter** lengths. Each meter is a **separate** strip with end connectors. Longer contiguous lengths are *not* offered in 144 pixels/m.
- **30** and **60** pixel/m NeoPixel strips are sold in **one meter multiples**. Orders for multiple meters will be a **single contiguous strip, up to a limit:** 4 meters for 60 pixels/m strip, 5 meters for 30 pixels/m.
- For **30** and **60** pixels/meter strips, if purchasing **less than a full reel** (4 or 5 meters, respectively), the strip **may or may not** have 3-pin JST plugs soldered at one or both ends. These plugs are for

factory testing and might be at **either end** — the plug does not always indicate the input end! **Arrows printed on the strip show the actual data direction. You may need to solder your own wires or plug.**

- The flex strips are **enclosed** in a weatherproof silicone sleeve, making them immune to rain and splashes, but are not recommended for continuous submersion. Early 144 pixel/meter strips were not weatherproof, but the current inventory now offers this feature.
- The silicone sleeve can be **cut and removed** for a slimmer profile, but this compromises the strip's weather resistance.
- **Very few glues will adhere to the weatherproof silicone sleeve.** Using zip ties for a “mechanical” bond is usually faster and easier. The only reliable glues we've found are Permatex 66B Clear RTV Silicone (not all silicone glues will work!) and Loctite Plastics Bonding System, a 2-part cyanoacrylate glue. Customers have reported *excellent* results with **Permatex Ultra Grey Silicone Gasket Maker** as well.
- However, **do not use Permatex 66B silicone to seal the open end of a cut strip!** Like many RTV silicones, 66B releases acetic acid when curing, which can destroy electronics. It's fine on the *outside* of the strip, but not the *inside*. Use **GE Silicone II** for sealing strip ends, or good ol' **hot melt glue**.
- **2-sided carpet tape** provides a light grip on the silicone sleeve; something like a Post-It Note. Or you can try **clear duct tape** over the top.
- **All LED strips** are manufactured in **1/2 meter** segments that are then **joined** into a longer strip. The pixel spacing across these joins is usually 2-3 millimeters different than the rest. This is not a manufacturing mistake, just physical reality.



Some batches of 144 pixel strip don't have pads between the LEDs. If you cut these into shorter sections, the only way to connect to them (except at the half-meter segments) is to carefully solder directly to the LED. The corner with the notch is the GND pin.

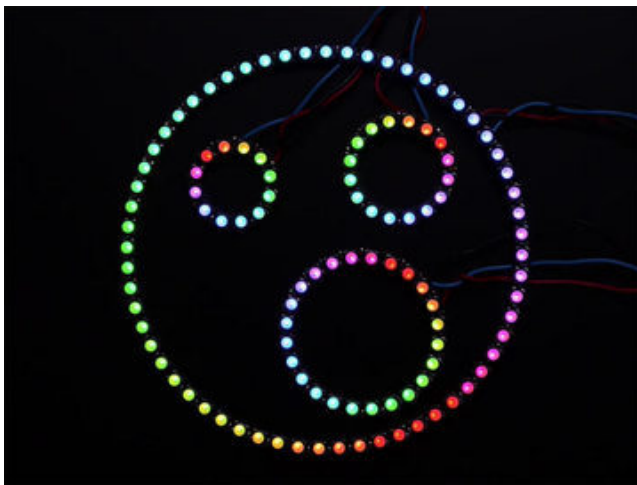
NeoPixel strips are just the start...we've got *shapes* too! Rings, grids, shields and more...

NeoPixel Rings

NeoPixel rings are **circular** rigid printed circuit boards festooned with NeoPixel LEDs. Originally designed for our [NeoPixel Goggles kit \(http://adafruit.it/2221\)](http://adafruit.it/2221), they proved so popular with other projects...timepieces, GPS wayfinders, jewelry, etc...that we now offer several sizes and varieties...

Rather than list a zillion different links, we have a single landing page for selecting among all the different NeoPixel ring products:

[NeoPixel Ring Product Selector \(http://adafruit.it/3042\)](http://adafruit.it/3042)



NeoPixel rings are offered in **12**, **16**, **24** and **60** pixel varieties.



60-pixel rings are actually sold as **15**-pixel *quarters*. For a **full circle**, you'll need to purchase **4** and **solder** them together. Or you might find creative ideas for individual arcs!

Number of Pixels	Outer Diameter	Inner Diameter
------------------	----------------	----------------

12	37 mm / 1.5"	23 mm / 1"
16	44.5 mm / 1.75"	31.75 mm / 1.25"
24	66 mm / 2.6"	52.5 mm / 2.05"
60 (4x 15-pixel arcs)	158 mm / 6.2"	145 mm / 5.7"

All rings are about 3.6 millimeters / 0.15" thick (1.6 mm for PCB, 2 mm for NeoPixels).



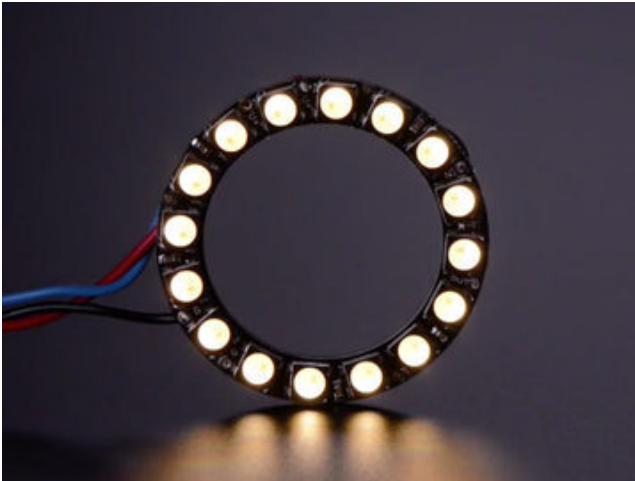
RGB NeoPixels are the most affordable and can produce *millions* of color combinations.

RGBW NeoPixels offer an eye-pleasing “true” white *in addition* to RGB. These are available in three different color temperatures:

- **Cool white:** approximately **6000** Kelvin (K).
- **Neutral:** approx **4500K**.
- **Warm white:** approx. **3000K**.



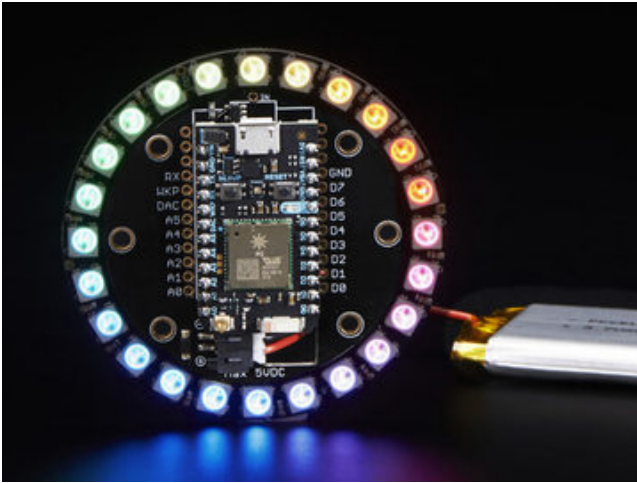
RGBW pixels incorporate a translucent **diffuser** layer to help mix and soften the light output. This makes them appear less intense than RGB pixels (which are “water clear”), but it’s really the same LEDs inside.



Finer Details About NeoPixel Rings

- When soldering wires to these rings, you need to be extra vigilant about solder blobs and short circuits. The spacing between components is *very* tight! It’s often easiest to **insert the wire from the front and solder on the back**.
- If using alligator clips, we recommend first soldering short jumper wires to the ring inputs and connecting the clips to those, for similar reasons. *(Some of our tutorials and product photos do show alligator clips directly connected to the rings, but we’ve had a lot of experience using them.)*

There’s also a [24-pixel RGB ring](http://adafru.it/2268) (<http://adafru.it/2268>) specifically designed



for the Particle (formerly Spark) **Photon** development board.

This one's not “see-through” like the others — the space at the center provides a socket for the [Photon board](http://adafru.it/2721) (<http://adafru.it/2721>).

NeoPixel Matrices

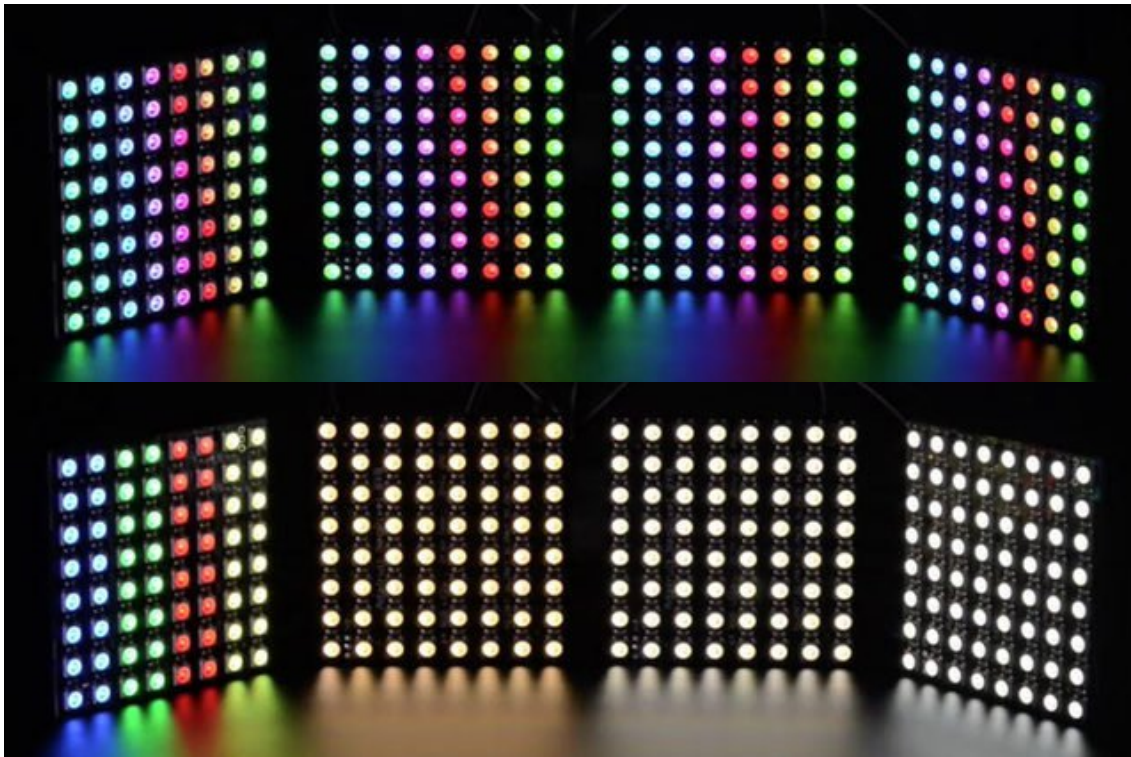
NeoPixel matrices are two-dimensional *grids* of NeoPixels, all controlled from a single microcontroller pin.

Rigid 8x8 NeoPixel Matrices

Like NeoPixel rings, these 64-pixel matrices are assembled on a rigid printed circuit board and are available in both **RGB** and **RGBW** varieties.

[NeoPixel Matrix Product Selector \(http://adafru.it/3052\)](http://adafru.it/3052)

All measure 71 millimeters (2.8 inches) square and about 3.6 mm thick. There are several mounting holes, and the DOUT pin allows **multiple matrices to be linked** in series.



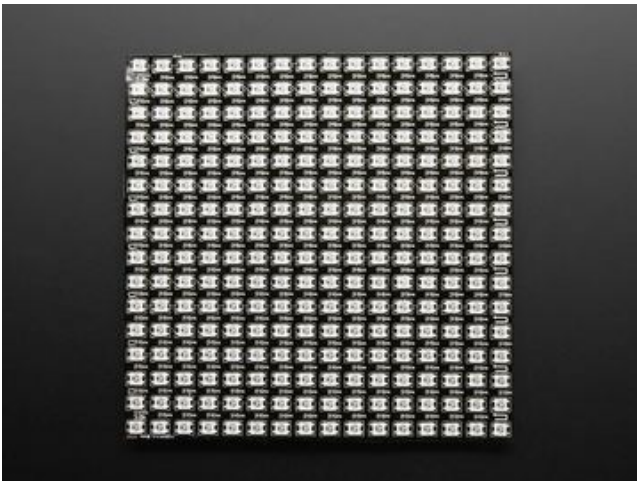
RGB NeoPixels are the most affordable and can produce *millions* of color combinations.

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- **Cool white:** approximately **6000** Kelvin (K).
- **Neutral:** approx **4500K**.
- **Warm white:** approx. **3000K**.

RGBW pixels incorporate a translucent **diffuser** layer to help mix and soften the light output. This makes them appear less intense than RGB pixels (which are “water clear”), but it’s really the same LEDs inside.

Flexible NeoPixel Matrices



Flexible NeoPixel matrices are available in three different sizes:

- [8x8 RGB pixels \(http://adafru.it/2612\)](http://adafru.it/2612)
- [16x16 RGB pixels \(http://adafru.it/2547\)](http://adafru.it/2547)
- [8x32 RGB pixels \(http://adafru.it/2294\)](http://adafru.it/2294)

Size	Dimensions	Total # of LEDs	Max Power Draw (approx)
8x8	80 mm / 3.15" square	64	19 Watts (3.8 Amps at 5 Volts)
16x16	160 mm / 6.3" square	256	77 Watts (15 Amps at 5 Volts)
8x32	320 mm x 80 mm / 12.6" x 3"	256	77 Watts (15 Amps at 5 Volts)

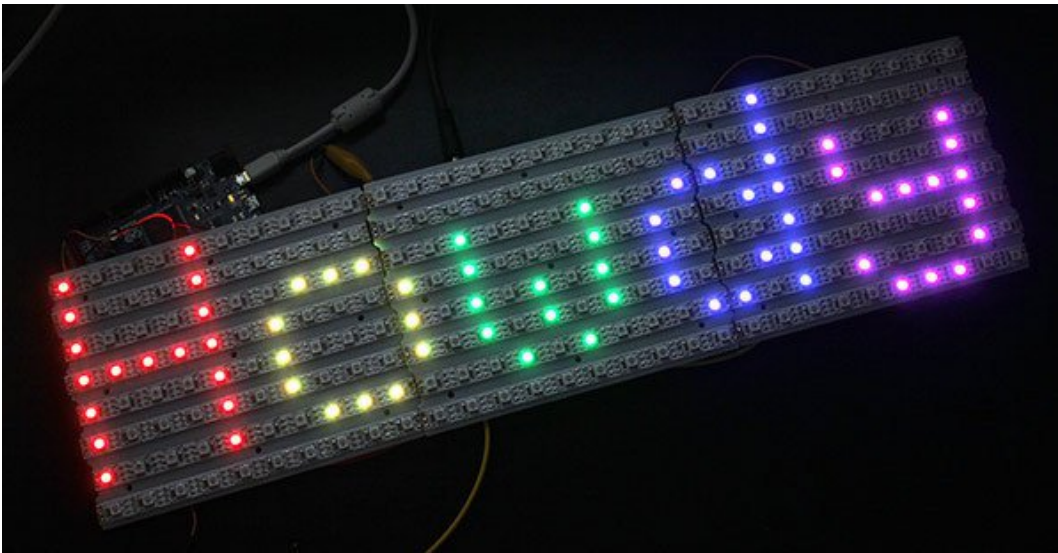
Flex matrices are about 2 millimeters (0.08 inches) thick.

Though called “flexible,” **these matrices do not tolerate continuous and repeated bending.** “Formable” might be a better word — they can be bent around a rigid or semi-rigid shape, like a hat. Repeated flexing (as on costumes) will soon crack the solder connections. (The videos on the product pages are to highlight just how flexible these matrices are, but this really is a “don’t try this at home” thing.)

Flex matrices are available with **RGB pixels only**; RGBW is not offered.

Finer Details About NeoPixel Matrices

As mentioned on the NeoPixel Strips page, keep power consumption in mind when working with NeoPixel matrices. With so many pixels at your disposal, it’s easy to get carried away.



If you need a size or shape of NeoPixel matrix that’s not offered here, it’s possible to **create your own** using sections of **NeoPixel strip!**

NeoPixel matrices don't enforce any particular "topology" — some may have rows of pixels arranged left-to-right, others may alternate left-to-right and right-to-left rows, or they could be installed in vertical columns instead. **This will require some planning in your code.** Our *NeoMatrix* library supports most matrix topologies.

We also have a few special-purpose matrices on the NeoPixel Shields page!



NeoPixel Shields

Though not all “Shields” in the strictly-speaking Arduino sense, a few NeoPixel products are designed to fit directly atop (or below) certain microcontroller boards...

NeoPixel Shield for Arduino

This 5x8 [NeoPixel Shield for Arduino](http://adafru.it/1430) (<http://adafru.it/1430>) fits neatly atop an Arduino Uno or compatible boards (5V logic recommended). Like many of our NeoPixel products, they're available in **RGB** and various **RGBW** pixel types:

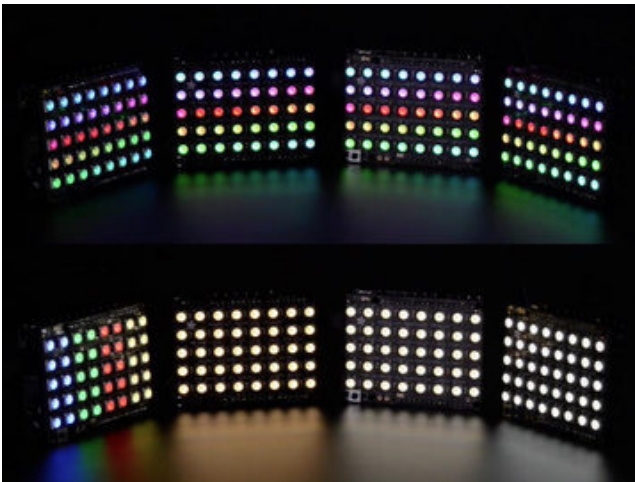
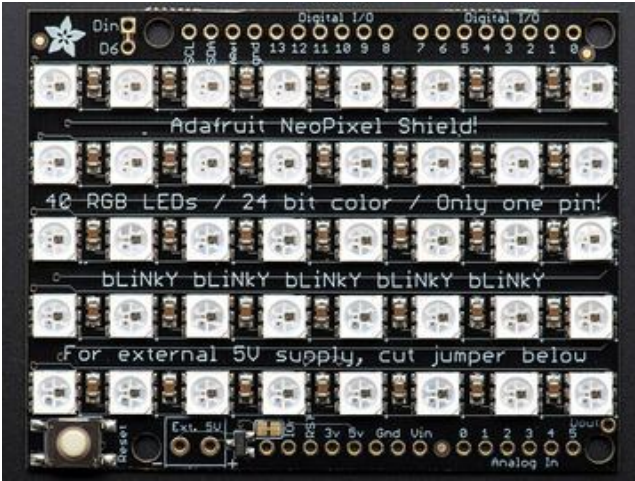
[NeoPixel Shield Product](#)



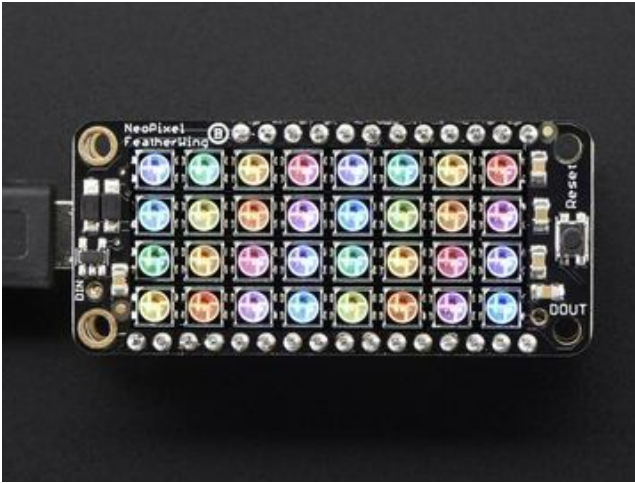
Selector (<http://adafru.it/ICw>)

By default, the LEDs are powered from the Arduino's 5V pin. As long as you *aren't* lighting up all the pixels at full brightness that should be fine. Or power the shield with an external power supply by soldering the included terminal block.

The NeoPixels are controlled on **digital pin 6**, but with some deft wiring you could change this to any pin.



NeoPixel FeatherWing



Quite possibly *The Cutest Thing in the History of Cute Little Things*, the [NeoPixel FeatherWing](http://adafru.it/2945) (<http://adafru.it/2945>) is a 4x8 pixel matrix that fits *perfectly* atop any of our [Feather microcontroller boards](http://adafru.it/17B) (<http://adafru.it/17B>).

The NeoPixels are normally controlled from **digital pin 6**, but pads on the bottom make this reassignable. In particular, **the default pin for Feather Huzzah ESP8266 must be moved, try pin #15!**

The NeoPixel Featherwing is **RGB** only; there's no RGBW version.



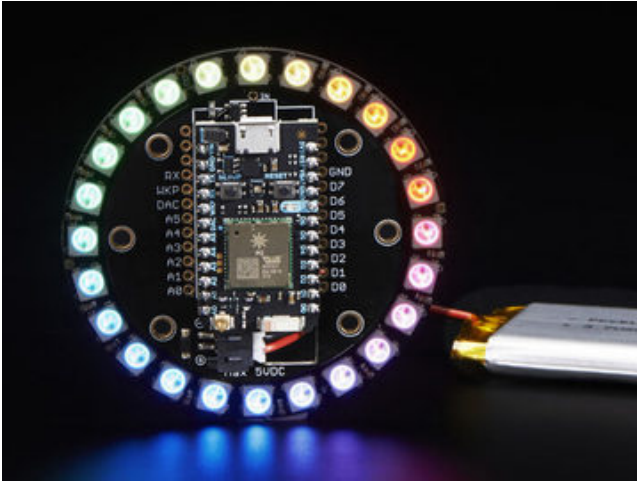
Pimoroni Unicorn Hat



The [Pimoroni Unicorn Hat](http://adafru.it/2288) (<http://adafru.it/2288>) is aptly named after a mythical animal — normally we'll say that NeoPixels don't work with the Raspberry Pi, but Pimoroni has worked up some [magical software](http://adafru.it/1Cx) (<http://adafru.it/1Cx>) that makes this combination possible! It's an 8x8 RGB matrix that fits neatly atop the Raspberry Pi Model A+, B+ or Pi 2.

Due to the way Unicorn HAT works, you can't use your Pi's analog audio alongside it. If you see odd random colour patterns and flickering make sure analog audio is disabled.

Particle/Spark NeoPixel Ring Kit



Previously mentioned on the “Rings” page, but for posterity: this [24-pixel RGB ring](http://adafru.it/2268) (<http://adafru.it/2268>) is specifically designed for the Particle (formerly Spark) **Photon** development board.

Other NeoPixel Shapes

NeoPixel Stick



The simplest thing...a row of **8 NeoPixels** along a rigid circuit board. These make great bargraph indicators!

Like our rings and matrices, NeoPixel sticks are available in **RGB** and **RGBW** varieties.

[NeoPixel Stick Product Selector \(http://adafru.it/3039\)](http://adafru.it/3039)



All measure 51.1 x 10.2 millimeters (2.0 x 0.4 inches).

NeoPixel Jewels