

Pixels & E1.31

Introduction to RGB Pixel displays and how to control them using sACN/E1.31

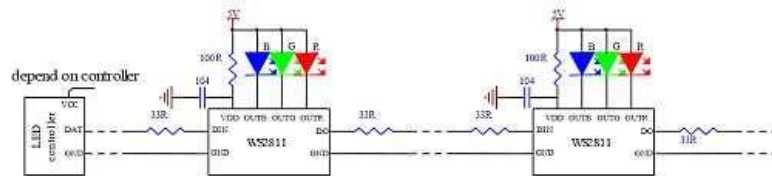
A workshop brought to you by the fine folks at [VHS](#) (Vancouver Hack Space)

v3.23.2020

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Pixel Basics

- A Pixel consists of 3 LEDs (RGB) and a controller IC.
- The Pixel controller IC reads the serial input stream, adjusts its RGB LED PWM output, strips its RGB data from the stream and then send the remaining stream to the next pixel. Each pixel does this in line till the end where there is a single RGB value left for the last pixel in the string.

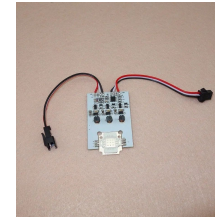
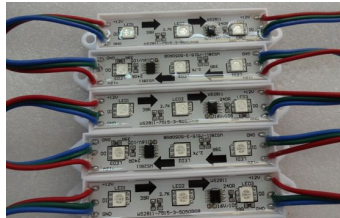
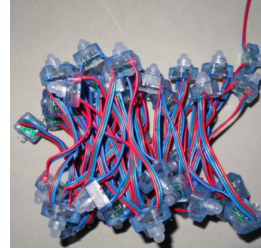
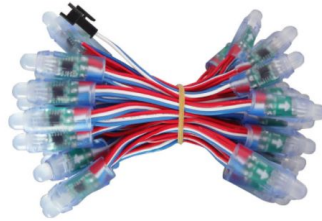
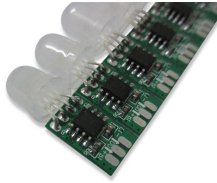


- Adafruit's NeoPixel and the FastLED project are free, well supported and very popular libraries for both Arduino and ESP8266 variant microcontrollers.

Pixel Info

- The WS281x (WS2811, WS2812, WS2813, etc) series is the most popular but there are many others with the main difference being dimming range (5 bit to 12 bit) and LED driver type (CC vs CV).
- While typically Pixels run on 5V, there are 12V and 24V versions. The higher voltage versions typically use resistors or linear regulators to lower the voltage so actually use more power than the 5V versions. But these do allow for longer runs before voltage drop on the power lines becomes an issue.
- Waterproofing can be really be an issue in our winters. Strips do not last long outside. Bullets are better. Any will tend to fail if stress is put on wires. Best to try to protect from elements as much as possible.
- The WS281x chips like a 5V data signal so best to use a driver/buffer if your uC is only 3.3V (ESP variants).
- Pixels come in various form factors ranging from single 5050 style chips, strips of 5050 chips, single 8mm LEDs, bullet modules, puck modules, etc. Some have a single LED and some have multiple LEDs.

Pixel Packages



Pixel Displays

- Xmas lighting displays are a very popular use of Pixels and have driven the development of affordable software and controllers.
- Examples shown in workshop are examples of easy to build displays that can be controlled in a variety of ways.
- Your options are limitless subject to your imagination (and budget).
- And if you want to go wild you can certainly get to here:
https://www.youtube.com/watch?v=MnL0_CsXncI
Or something a bit more subdued:
<https://www.youtube.com/watch?v=ajKlgDfYtNo>

DMX

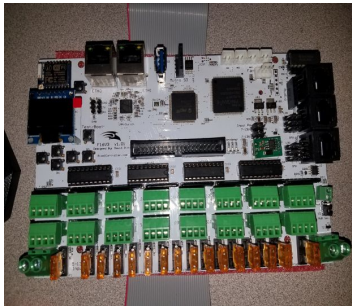
- Single DMX universe contains 512 channels.
- Each channel has an 8 bit value which allows for 256 levels of control.
- Data updates 44x per second.
- No error correction.
- Uses RS-485 signaling over twisted pair cabling that can run over 1000 feet.
- To go over 512 channels you can add another universe but this requires a new cable run.
- DMX specifications call for 120 Ohm impedance cable along with 5 pin XLR connectors with 120 Ohm terminators specified for end of cable run.
- Common practice had lead to use of 3 pin XLR and microphone cabling (YMMV).
- Cat5 network cable meets DMX specifications.

sACN/E1.31 DMX over Ethernet

- Streaming Architecture of Control Networks (sACN) or E1.31 sends DMX over Ethernet.
- Single E1.31 packet has 512 channels (1 DMX universe) of data.
- You can have 62,999 universes in a single network.
- You can run 100's of universes in a typical 100 Meg wired Ethernet network.
- Can be sent Unicast (to specified IP address) or Multicast (to known groups IPs that are based on Universe value)
- You may need to configure Multicast on routers and IGMP on switches depending on your network equipment
- Only option with larger Pixel displays due to the huge number of channels required.

Pixel Controllers

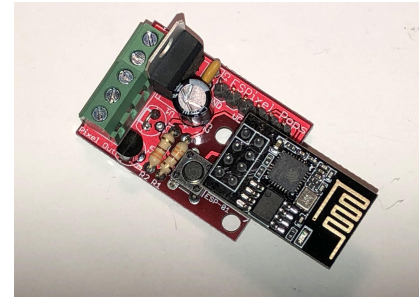
- For small displays you can use a uC and one of the well supported libraries but this can be limiting for large displays
- Another option is a DMX based controller. This opens up the option to use DMX based controller or sequencing software but you are limited to 170 Pixels (510 channels) per DMX controller.
- For large displays your best bet is a E1.31 based controller. Choices run from DIY projects (like the ESPixelStick) to various commercial products. These controllers have ranges of options and capacities.



Falcon F16V3



SanDevices E682

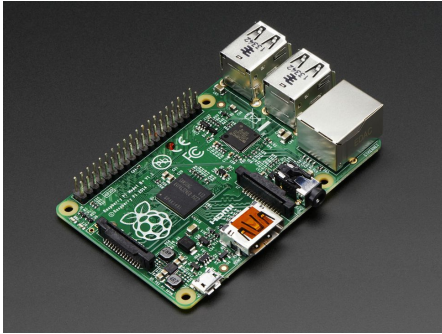


ESPixelPOPs

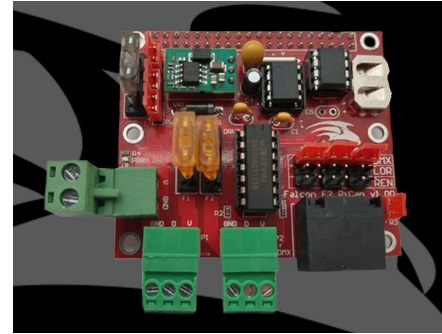
Falcon Player

Stand alone player for xLights (and other software) sequences

- Plays sequences from a playlist (with a scheduler)
- Streams audio
- Can stream video (HDMI output on Pi)
- Can send E1.31 (directly over wired or Wi-Fi Ethernet to any E1.31 controller)
- Can send DMX (with USB connected DMX dongle to any DMX controller)
- Can drive Pixels directly (with add on card Falcon PiCap)
- Various interfaces for triggering sequences



Works with wide range of Raspberry Pi models



Add on PiCap to drive Pixels directly

Pixel Software

- [Jinx](#) is control software for pixel matrix panels. It is more geared to DJ type lighting effects and can drive Pixel panels over a wide variety of interfaces including serial, DMX & E1.31.
- [xLights](#) is sequencing software for pixels (Vixen3 is another such program) Both have come from the DIY Xmas lighting communities. These allow you to sequence your light display to music. Each has a variety of output options to control lights (and pretty much anything) via serial, USB, DMX, E1.31 and various other options. Both are quite well supported and have a large community following.

More Pixel Software

And there is a host of other lighting control applications that support E1.31 (sACN). Here are some free ones:

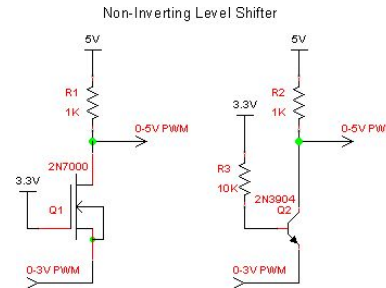
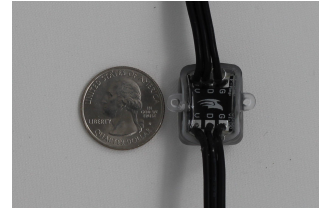
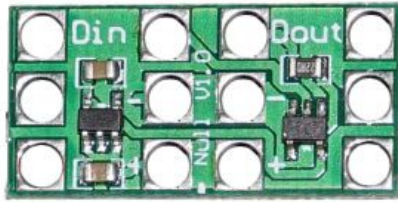
- [LX Studio](#)
- [MaizeDMX](#)
- [DMXControl](#)
- [FreeStyler](#)
- [QLC+](#)
- [MagicQ](#)
- [ShowMagicSL](#) (24 channels free)
- [Onyx](#) (4 universes free)
- [MAdot2PC](#) (1 universe free)
- [Photon](#)

Note that these are more theater or show related and not designed specifically for Pixels

Null Pixels & Boosters

- One aspect of Pixels that can affect your creativity is the physical limitation of the distance between Pixels. Type of cabling, cable layout, interference sources and many other things can affect how far you can go before your Pixels stop responding properly (1 to 3 meters)
- Since a Pixel regenerates the data signal you can use one (or several) in the middle of a longer cable run. These are referred to as Null Pixels and you can just cover the LED so you don't see any light from it. When sequencing lights you do need to allow for these and this can be typically done in your controller configuration or your sequencing software.
- You can also get boosters that do the same thing but don't count as a Pixel (this avoids having to allow for the extra Pixel in your configuration)
- You can also get driver circuits that convert the Pixel signal output from your controller into a differential signal. This signal can be run over Cat5 cabling and you can go hundreds of feet. You need a matching receiver on the display side of the connection.

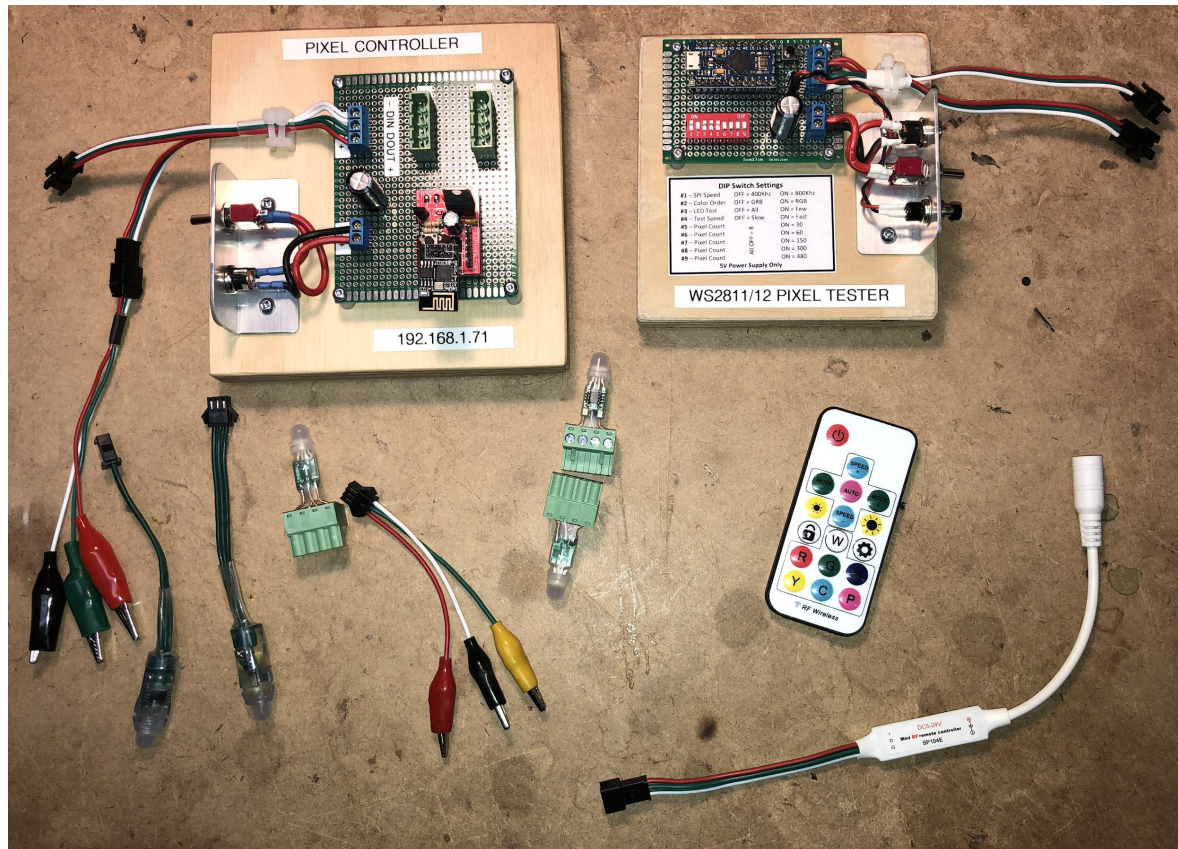
Pixel Buffers & Boosters



Pixel Testing

- Very handy to have either a stand alone pixel tester (can be purchased or you can configure an uC to send pixel data sequences) or a spare controller that you use to send data from. Most pixel controllers also have a basic test function.
- Also good to have test Pixels that you can connect to your controllers
- You can also send test data from your sequencing software or use one of the E1.31 test applications like da_Tester or sACNView.
- Good idea to break large displays into smaller parts and do a burn-in test prior to final assembly.
- Pixels don't seem to have great quality control and some will fail. It's a good idea to design and build your displays with replacing pixels in mind.

Pixel Testers



Pixel Caveats & Issues

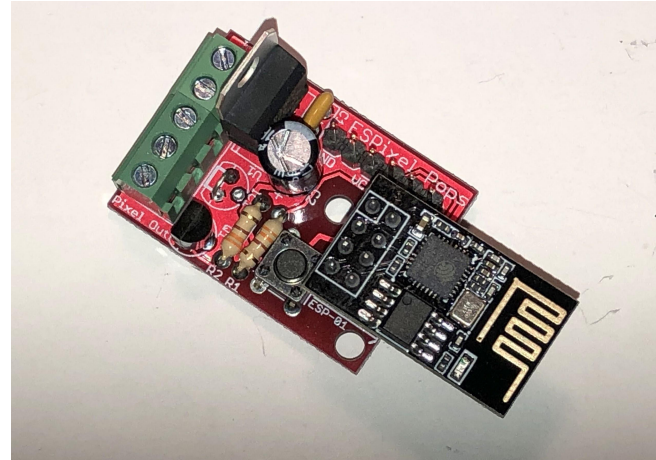
- **Power Supplies**
- **Power Wiring**
- **Data Wiring**
- **Wiring Color Coding**
- **Wi-Fi**
- **Multicast vs Unicast**
- **Brightness**
- **Channel Mapping**
- **Purchasing**

ESPixelPOPs Kit

Included in this workshop is a kit to build a Wi-Fi enabled, ESP8266 based, E1.31 Pixel controller and a strip of WS2812 pixels to enable you to get started with lighting control. The ESpixelPOPs runs the ESpixelStick firmware which can drive up to 680 (4 DMX Universes) of WS281x Pixels (or 63 GECE pixels).

The ESpixelPOPs is designed to be compact and uses all through hole components for ease of soldering and a detailed build and setup guide can be found here:

<http://zappedmyself.com/vhs/pixels-and-e1-31-workshop/>



The ESpixelStick software can be run on any ESP8266 variant, you just need to add a buffer between the 3.3V output of the ESP8266 and the 5V data input line of the WS2811 pixels.

The ESpixelStick firmware has a version that will output a single DMX universe instead of Pixel Data. You need to add a RS-485 interface. This is used in the PIXIE-1 DMX Flood display

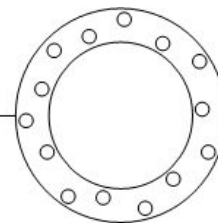
DMX Flood Lights

DMX
FLOOD 1
Ch: 4-6

DMX
FLOOD 2
Ch: 4-6

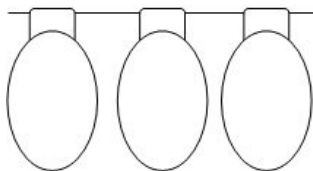
PIXIE-1 DMX
10.10.10.11
DMX Output (Ch: 4,5,6)
Universe: 1 / Ch: 1-512
xLights Channels 1-512

PIXIE-4 WREATH
10.10.10.14
14 Pixels 42 Channels
Universe: 4 / Ch: 1-42
xLights Channels 603-644



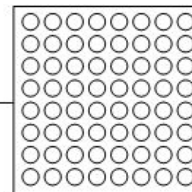
Wreath 14 Bulbs

RBL String 10 Bulbs



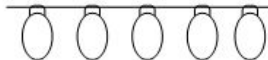
PIXIE-2 RBL
10.10.10.12
10 Pixels 30 Channels
(10 Groups of 3)
Universe: 2 / Ch: 1-30
xLights Channels 513-542

PIXIE-5 PANEL
10.10.10.15
64 Bulbs 192 Channels
Universe: 5 / Ch: 1-192
xLights Channels 645-836



Panel 64 Bulbs

Pixel String 20 Bulbs



PIXIE-3 STRING
10.10.10.13
20 Pixels 60 Channels
Universe: 3 / Ch: 1-60
xLights Channels 543-602

PIXELPOPx
DHCP (User Kits)
30 Pixels 90 Channels
Universe: 1 / Ch: 1-90



Strip 30 Pixels



Test Laptop
DHCP

WAP
SSID: PIXELNET
PW: pixelnet
10.10.10.1 /24
(DHCP 100-200)

VHS PIXEL WORKSHOP
07/03/2020
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Pixel Resources

- Pixel Basics Guide
- <https://learn.adafruit.com/adafruit-neopixel-uberguide>
- Pixel Libraries
- https://github.com/adafruit/Adafruit_NeoPixel
- <http://fastled.io/>
- Xmas Lighting Sites
- <http://doityourselfchristmas.com/forums/forum.php>
- <https://diychristmas.org/vb1/forum.php>
- <https://auschristmaslighting.com/wiki/AusChristmasLighting-101>
- <http://www.billporter.info/2017/01/07/the-engineers-guide-to-diy-computer-controlled-holiday-lights/>
- Software
- <http://www.live-leds.de/>
- <https://xlights.org/>
- https://www.da-share.com/software/da_tester/
- <https://sacnview.org/>
- Controllers
- <https://www.pixelcontroller.com/store/index.php>
- <https://sandevices.com/shop/>
- ESPixelStick (and variants)
- <https://github.com/forkineye/ESPixelStick>
- http://www.doityourselfchristmas.com/wiki/index.php?title=ESPixel_Stick_%26_ESPixel_Pops
- Fantastic spreadsheet detailing various pixels, controllers and software
- https://docs.google.com/spreadsheets/d/10pHG7_VIVltyqJK1Y0T5g3lq6YJV2MnhMp3UcAVB-GA/

The End (but the beginning of your lighting adventure!!)

Any questions?

Any comments?

I will hold a ad-hoc follow up workshop for anyone that needs help with the included ESPixelPOPs controller kit and I do have ESPixel POPs PCBs and kits available for sale.

Please post any follow up questions or comments on the VHS Talk site (<https://talk.vanhack.ca/>)

Thanks for participating in this VHS workshop.