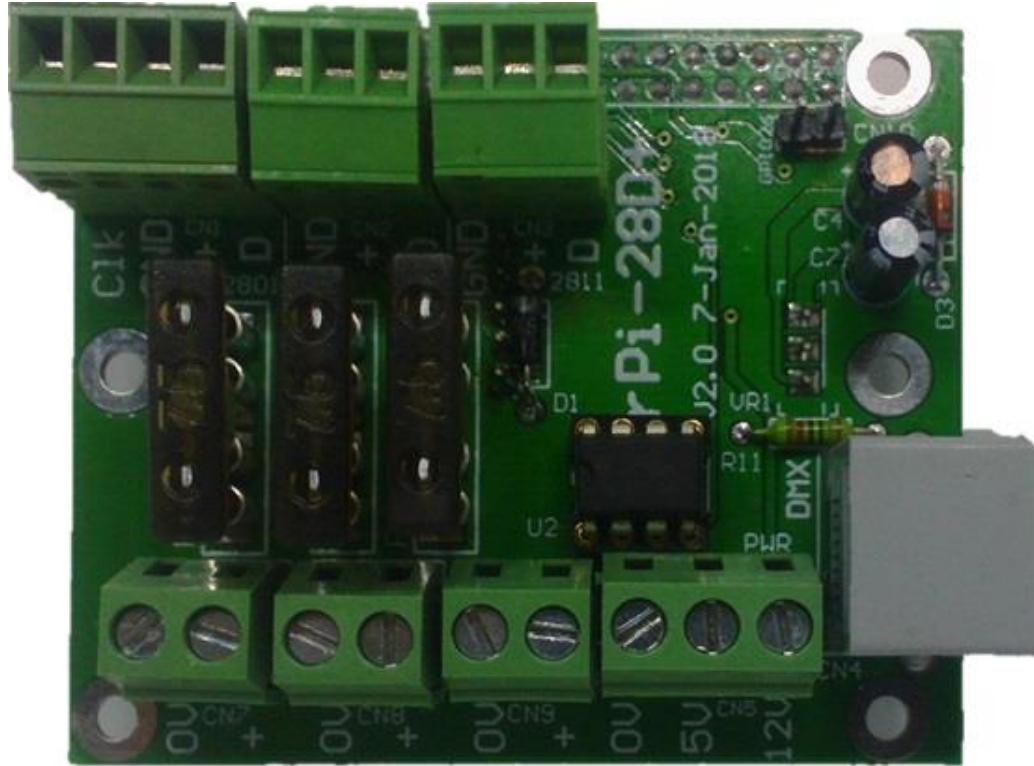


HANSON ELECTRONICS



rPi-28D+ USER MANUAL

Features

- Suits Raspberry Pi 2, 3, 3B+, 4 and Zero
- 2 WS281x compatible outputs (WS2811, 2812, 2813, INK1003 etc)
- 1 WS2801 compatible output
- 1 DMX output. Can be software configured for DMX, Renard, LOR
- 1 GPIO input that can be configured in software for triggers
- Real time clock to allow standalone scheduled playback
- 5V or 12V power (12V is 12-24V tolerant)
- 3 fused power inputs for 3 pixel outputs. ATO fuse with max size of 10A.
- PCB size is 67mm x 56mm

Revision 1.1
Suits PCB revision 1.0
FPP Version 4.x
25 November, 2020

The rPi-28D+ is a cape/hat that is designed to add pixel and DMX (RS485) capability to the Raspberry Pi series of single board computers. The hat mounts to the 40 way male header of the Raspberry Pi 2, Raspberry Pi 3, Raspberry Pi 3B+ or Raspberry Pi Zero and attaches via the supplied nylon M2.5 screws, nuts and standoffs. The rPi-28D+ powers the Raspberry Pi so there is no need to supply power to the Pi separately. The rPi-28D+ is controlled by Falcon Player (FPP) running on the Pi. FPP downloads and its documentation is at falconchristmas.com . To run Pi 3B+ or later FPP version 2.5 or later is required.

Using the WS2811 outputs disables the onboard audio and an external USB audio must be plugged in and configured if needed.

The DMX output is designed for the RJ45 connector to be placed along the same axis as the Ethernet connector for the Pi.

The power connectors are located on the same side as the Pi audio and video output connectors.

Note:- The rPi-28D+ is supplied as a board only with mounting hardware. The Raspberry Pi, USB thumbdrive and SD storage device and any cables are not supplied.

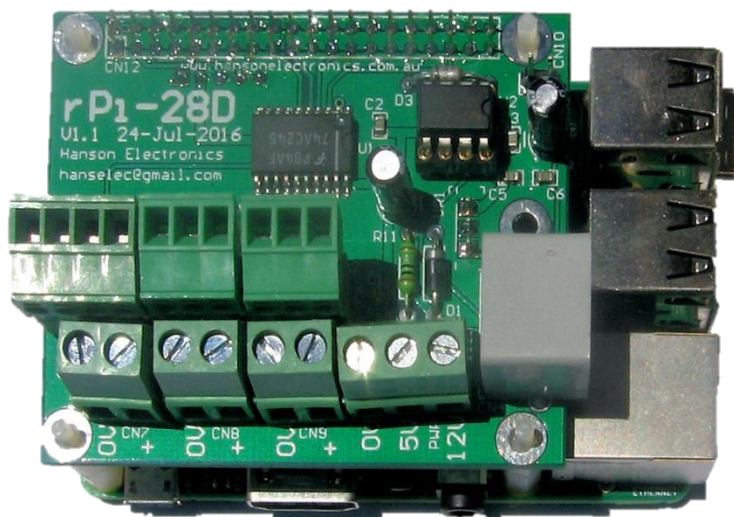
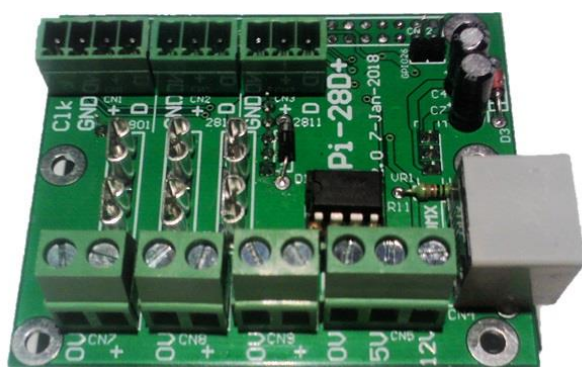
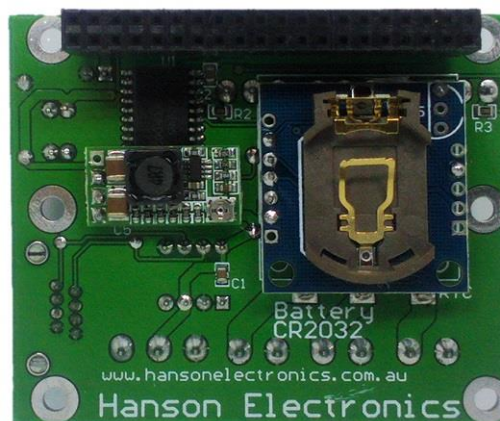


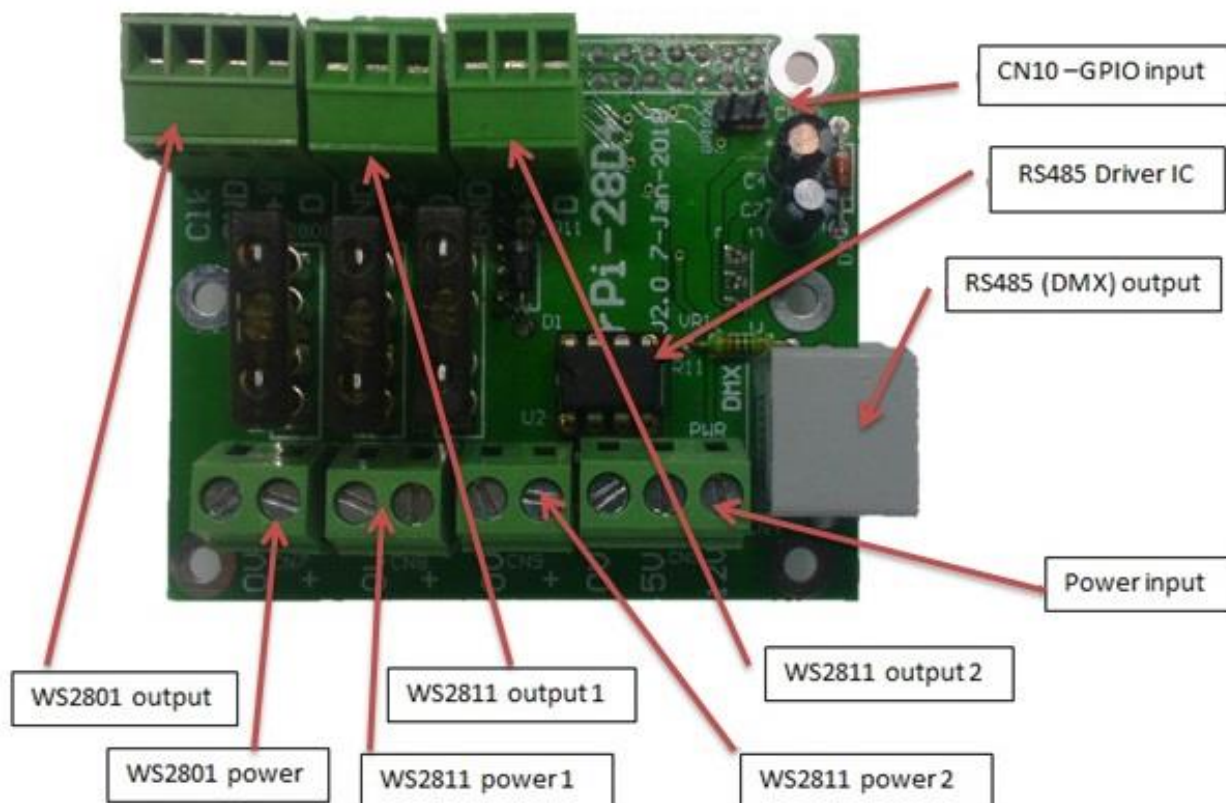
Photo shows an rPi-28D mounted to a Pi. The rPi-28D+ mounts in the same position



rPi-28D+ with fuses and pluggable pixel connectors removed



Underside of rPi-28D+. RTC uses CR2032 battery (not supplied or installed)



The 3 pixel connectors are pluggable and the function of each of the pins is labelled on the pcb. The 3 connectors for the pixel power are simple pass through to the matching pixel output connectors. The power connectors are each labelled with 0V and +. Each of the 3 pixel outputs is fused with an ATO automotive fuse. 7.5A fuses are supplied fitted with a maximum size of 10A permissible.

Power

The rPi-28D+ can be powered from either 5V DC or 12V DC although the 12V is actually tolerant of any voltage in the range of 9V to 24V. The connected Raspberry Pi is powered from the same power source. You can power the rPi-28D+ off the Raspberry Pi's power input if absolutely necessary or desired.

If running the rPi-28D+ from 5V then connect the power to the 0V and 5V terminals of CN5 the 3 pin PWR terminal block. A 2A fuse is recommended in series.

If running off 12V (see range above) then connect the power to the 0V and 12V terminals of CN5. A 1A fuse is recommended in series.

The 3 pixel outputs can be powered from the same or different voltage power supplies. The pluggable pixel connectors are rated at 7.5A so a fuse of no higher than 7.5A should be in series with the power input.

Connecting 12V to the 5V power input will damage components on the pcb and may damage the Raspberry Pi. Connecting 5V to the 12V input will cause the board to not work due to insufficient voltage. Connecting the power in reverse can also damage the board and Pi.

Terminology

Throughout this manual and on power supplies, pixels and power distribution boards etc there are a number of terms that are used where there can be several terms for the same thing.

Ground=Gnd= -V = V- = 0 = 0V = G

This is the negative voltage supply

Positive = +V = V+ = Positive power = Power = 5V (or 12V)

This is the positive voltage supply

Data In = Din = DI = ^ (up arrow)

This is the data input

Data Out = D = Dout = DO = V (down arrow)

This is the data output

Clock = Clk = C = Co = Cout

This is the clock output on 4 wire pixels

Ci = Cin

This is the clock in on 4 wire pixels

Falcon Player (FPP) configuration

This board is designed to be controlled via Falcon Player on a Pi and as such there are a number of settings that need to be configured.

In a lot of cases the rPi-28D+ will be used as an E1.31 “pixel” controller but it’s actually pixel, and DMX that can be controlled.

The channels used for the outputs must be configured under the Input/Output Setup and E1.31 Bridge screen. The number of universes, number of channels per universe and their FPP start channel needs to be configured to match the sequencer that you are using.

The DMX output will typically be configured as 1 universe of 512 channels although it can be configured for less. Pixel outputs will generally be configured with universe sizes that are divisible by 3 (as most pixels are 3 colours and use 3 channels). This means that they will usually be set as 510 channels rather than 512.

Network Setup

After initially accessing FPP I recommend setting a static IP in the same network range as your computer/s and router. These will typically be in the 192.168.0.x or 10.0.x.x ranges. The netmask of 255.255.255.0 is typical but 255.255.0.0 can be used if computer and FPP are in slightly different IP ranges eg. 10.0.0.x and 10.0.1.x . The Gateway IP is generally set to the IP address of your router.

A DNS server will need to be configured if FPP is to access the internet for time servers or for updates via Github. The use of Googles free DNS servers of 8.8.8.8 and 8.8.4.4 can be used or alternately you can use the DNS server/s of your ISP.

The screenshot shows the Falcon Player (FPP) web interface for network configuration. The browser address bar shows '10.0.0.5/networkconfig.php'. The page title is 'Falcon Player - FPP' with version 'v4.3' and host 'FPPMFC1 (eth0:10.0.0.5)'. The interface has a navigation bar with 'Status/Control', 'Content Setup', 'Input/Output Setup', and 'Help'. The 'Network Configuration' section is active, showing 'Interface Settings'.

Interface Settings:

- WIFI Drivers: External
- WIFI Regulatory Domain: United States
- Select an interface name to configure the network information for that interface.
- Interface Name: eth0 (selected), wlan0
- Interface Mode: ☒ Static ☐ DHCP
- IP Address: 10.0.0.5 (Ping)
- Netmask: 255.255.255.0
- Gateway: 10.0.0.138 (Ping)
- Buttons: Update Interface, Create Persistent Names, Clear Persistent Names

Host & DNS Settings:

- HostName: FPPMFC1 (Save)
- Description: (Save)
- DNS Server Mode: ☒ Manual ☐ DHCP
- DNS Server 1: 8.8.8.8 (Ping)
- DNS Server 2: 8.8.4.4 (Ping)
- Button: Update DNS

Tethering:

- Tethering Mode: If no connection
- Tethering Interface: wlan0
- Tethering Technology: Hostapd
- Tethering SSID: FPP
- Tethering Pre Shared key (PSK): Christmas
- Warning:** Turning on tethering may make FPP unavailable. The WIFI adapter will be used for tethering and will thus not be usable for normal network operations. The WIFI tether IP address will be 192.168.8.1 for Hostapd tethering, but unpredictable for ConnMan (although likely 192.168.0.1).
- On the Pi Zero and Pi Zero W devices, USB tethering is available if using an appropriate USB cable plugged into the USB port, not the power-only port. Don't plug anything into the power port for this. The IP address for USB tethering would be 192.168.7.2.

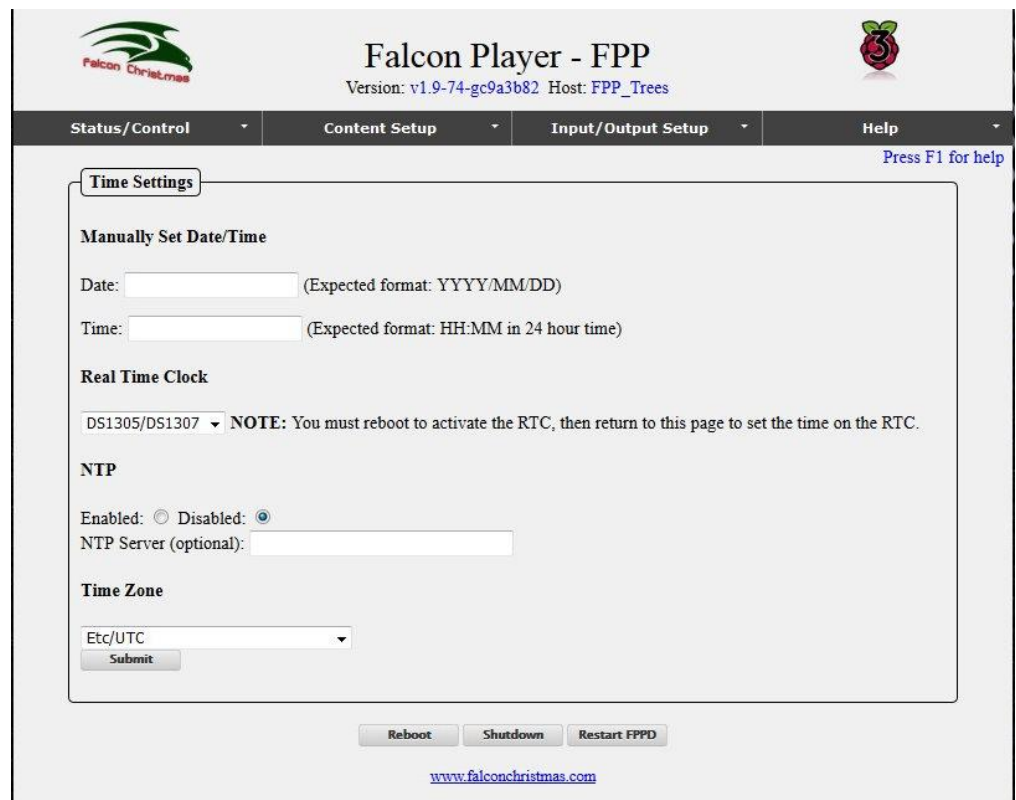
Interface Routing:

- ☐ Enable Routing between network interfaces

Buttons at the bottom: Reboot, Shutdown, Restart FPPD. Footer: www.falconchristmas.com

Real time clock


The rPi-28D+ real time clock (RTC) can be used if desired. No battery is supplied. A CR2032 battery is needed for battery backed time. It is configured as below under the Status/Control tab. The RTC is of DS1307 type. The battery is only needed if using the Pi on a network isolated from the internet and thus NTP time server and as a Master or Remote. If using in Bridge mode a RTC isn't needed.



The screenshot shows the 'Falcon Player - FPP' web interface. At the top, there's a header with the 'Falcon Christmas' logo on the left, the title 'Falcon Player - FPP' in the center, and a Raspberry Pi logo on the right. Below the header, a navigation bar contains four tabs: 'Status/Control', 'Content Setup', 'Input/Output Setup', and 'Help'. The 'Status/Control' tab is active. Below the navigation bar, there's a sub-header 'Time Settings'. The main content area is divided into three sections: 'Manually Set Date/Time', 'Real Time Clock', and 'NTP'. The 'Manually Set Date/Time' section has two input fields: 'Date:' (Expected format: YYYY/MM/DD) and 'Time:' (Expected format: HH:MM in 24 hour time). The 'Real Time Clock' section has a dropdown menu set to 'DS1305/DS1307' and a note: 'NOTE: You must reboot to activate the RTC, then return to this page to set the time on the RTC.' The 'NTP' section has radio buttons for 'Enabled:' and 'Disabled:' (selected), and an 'NTP Server (optional):' input field. Below these is a 'Time Zone' section with a dropdown menu set to 'Etc/UTC' and a 'Submit' button. At the bottom of the page, there are three buttons: 'Reboot', 'Shutdown', and 'Restart FPPD'. A link to 'www.falconchristmas.com' is also present.

USB Sound

When using the WS281x outputs of the rPi-28D+ the onboard sound of the Pi is disabled due to hardware restrictions. If sound is needed a USB sound card will need to be installed on the Pi and configured as below.



The screenshot shows the 'Falcon Player - FPP' web interface, specifically the 'Audio/Video' settings page. The browser window title is 'FPP - FPPMFC1' and the address bar shows '10.0.0.5/settings.php'. The page header is identical to the previous screenshot. The navigation bar has four tabs: 'Status/Control', 'Content Setup', 'Input/Output Setup', and 'Help'. The 'Status/Control' tab is active. Below the navigation bar, there's a sub-header 'FPP Settings'. The main content area is divided into several sections: 'Playback', 'Audio/Video', 'Time', 'UI', 'Email', 'MQTT', 'Logging', and 'System'. The 'Audio/Video' section is active. It contains the following settings: 'Audio Output Device:' (dropdown menu set to 'USB PnP Sound Device'), 'Audio Output Mixer Device:' (dropdown menu set to 'Speaker'), 'Default Video Output Device:' (dropdown menu set to 'HDMI'), and 'Disable IP announcement:' (checkbox). At the bottom of the page, there are three buttons: 'Reboot', 'Shutdown', and 'Restart FPPD'. A link to 'www.falconchristmas.com' is also present.

WS281x Pixel Outputs

The rPi-28D+ has 2 WS281x (WS2811, WS2812, WS2813, INK1003 etc) that can have up to 1600 pixels controlled at 20fps or 800 at 40fps (note this number is for FPP4.x).

The channels used for the pixel outputs must be configured under the Pi Pixel Strings tab of the Input/Output>Output Setup.

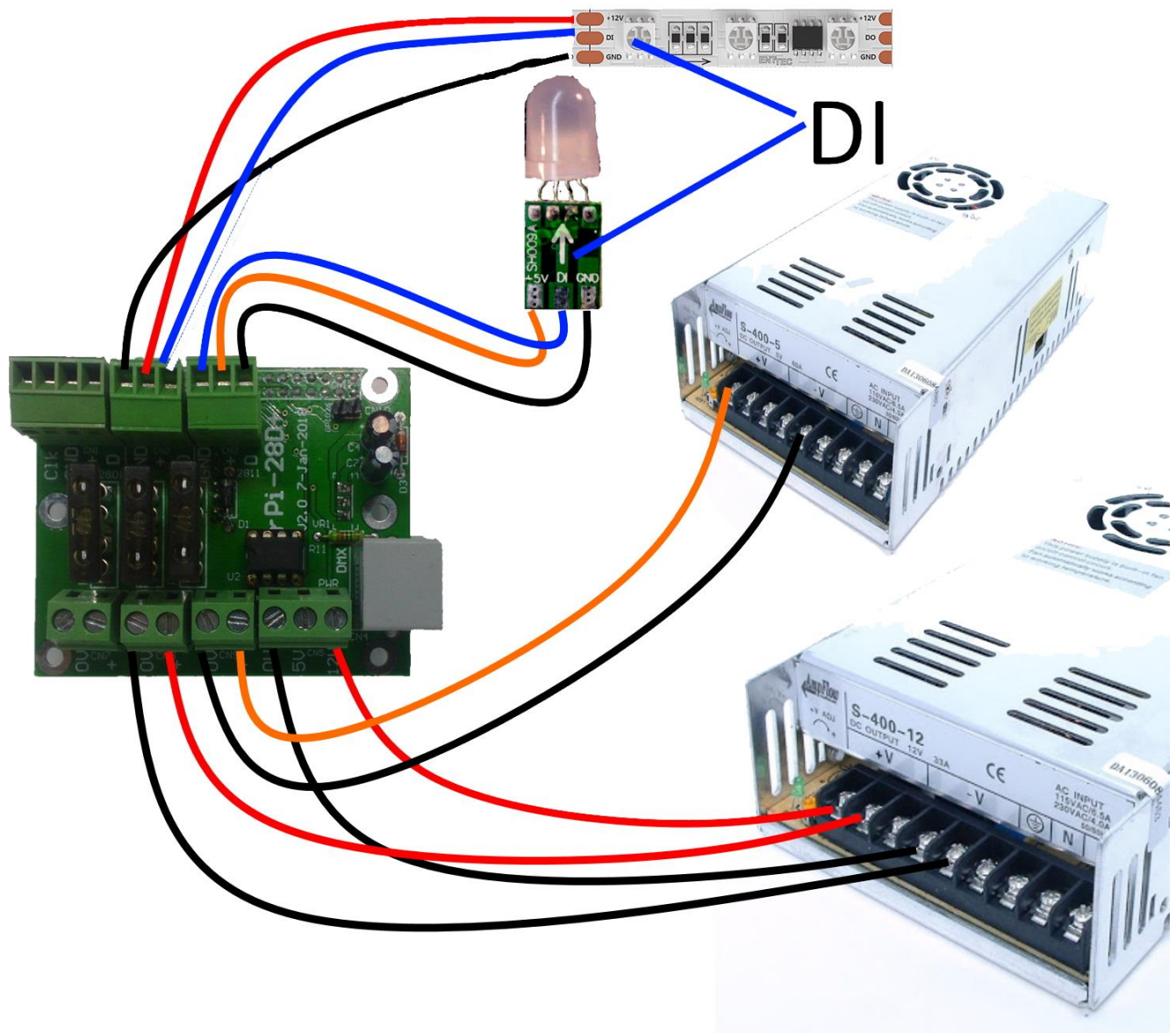
The screenshot shows the Falcon Player - FPP web interface. The browser address bar displays "10.0.0.23/channeloutputs.php". The page header includes the Falcon Christmas logo, the title "Falcon Player - FPP", and the version "Version: v3.0 Host: FPP (10.0.0.23)". The navigation menu has tabs for "Status/Control", "Content Setup", "Input/Output Setup", and "Help". The "Channel Outputs" section is active, showing tabs for "E1.31 / ArtNet / DDP", "Pi Pixel Strings", "LED Panels", and "Other". The "Pi Pixel Strings" tab is selected, displaying a "New Type" dropdown set to "RPIWS281X" and buttons for "Add Output", "Clone String", "Save", and "Revert". A note says "Press F2 to auto set the start channel on the next row." Below this, the "Output Enabled" checkbox is checked. The "RPIWS281X Output" table is shown with columns: Port, Protocol, Description, Start Channel, Pixel Count, Group Count, End Channel, Direction, Color Order, Null Nodes, Zig Zag, Brightness, and Gamma. Two rows are listed: Row 1 has Port 1, Protocol WS281X, Description, Start Channel 1, Pixel Count 0, Group Count 1, End Channel 0, Direction Forward, Color Order RGB, Null Nodes 0, Zig Zag 0, Brightness 100%, and Gamma 1.0. Row 2 has Port 2, Protocol WS281X, Description, Start Channel 1, Pixel Count 170, Group Count 1, End Channel 510, Direction Forward, Color Order RGB, Null Nodes 0, Zig Zag 0, Brightness 100%, and Gamma 1.0. At the bottom, there are buttons for "Reboot", "Shutdown", and "Restart FPPD", and a link to "www.falconchristmas.com".

Port	Protocol	Description	Start Channel	Pixel Count	Group Count	End Channel	Direction	Color Order	Null Nodes	Zig Zag	Brightness	Gamma
1)	WS281X		1	0	1	0	Forward	RGB	0	0	100%	1.0
2)	WS281X		1	170	1	510	Forward	RGB	0	0	100%	1.0

The screenshot shows the Falcon Player - FPP web interface. The browser address bar displays "10.0.0.23/channelinputs.php". The page header includes the Falcon Christmas logo, the title "Falcon Player - FPP", and the version "Version: v3.0 Host: FPP (10.0.0.23)". The navigation menu has tabs for "Status/Control", "Content Setup", "Input/Output Setup", and "Help". The "Channel Inputs" section is active, showing a tab for "E1.31 Bridge". The "E1.31 Bridge Mode Universes" section is highlighted. It features a "Universe Count" input field set to 3, with "Save", "Clone", and "Delete" buttons. Below this is a table with columns: Line #, Active, Description, FPP Start Channel, Universe #, Universe Count, Universe Size, and Universe Type. Three rows are listed: Row 1 has Line # 1, Active checked, Description, FPP Start Channel 1, Universe # 1, Universe Count 1, Universe Size 512, and Universe Type E1.31 - Multicast. Row 2 has Line # 2, Active checked, Description, FPP Start Channel 513, Universe # 2, Universe Count 1, Universe Size 512, and Universe Type E1.31 - Multicast. Row 3 has Line # 3, Active checked, Description, FPP Start Channel 1025, Universe # 3, Universe Count 1, Universe Size 512, and Universe Type E1.31 - Multicast. A note below the table says "(Drag entry to reposition)". At the bottom, there are buttons for "Reboot", "Shutdown", and "Restart FPPD", and a link to "www.falconchristmas.com".

Line #	Active	Description	FPP Start Channel	Universe #	Universe Count	Universe Size	Universe Type
1	<input checked="" type="checkbox"/>		1	1	1	512	E1.31 - Multicast
2	<input checked="" type="checkbox"/>		513	2	1	512	E1.31 - Multicast
3	<input checked="" type="checkbox"/>		1025	3	1	512	E1.31 - Multicast

Connecting to rPi-28D+



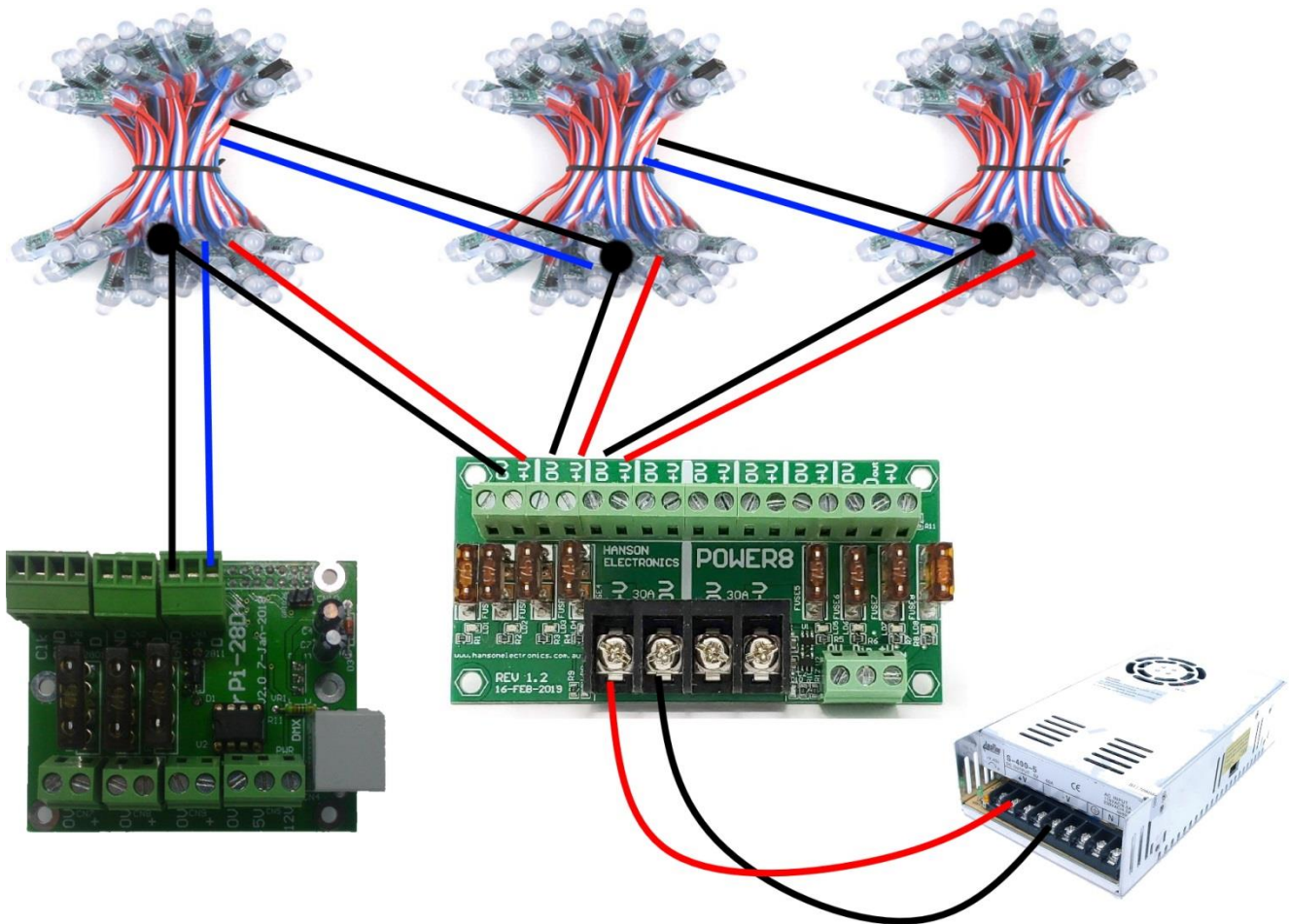
The image above shows a 5V power supply power, a 5V pixel node on 1 output and a 12V power supply powering the rPi-28D+, the Pi and 1 pixel (3 leds) of 12V WS2811 strip. No input fuse is shown for the power connection to the rPi-28+

Power Injection

Due to voltage drop in cables it will often be necessary to provide “power injection” through a string/prop. For 5V pixels it’s fairly typical for power injection to be provided every 50 pixels, with 12V pixels it’s often 100 pixels. With pixel strip it is fairly typical to inject power at each 4 or 5 metre end of the strip. These numbers are assuming that you are running at a global brightness of 100%.

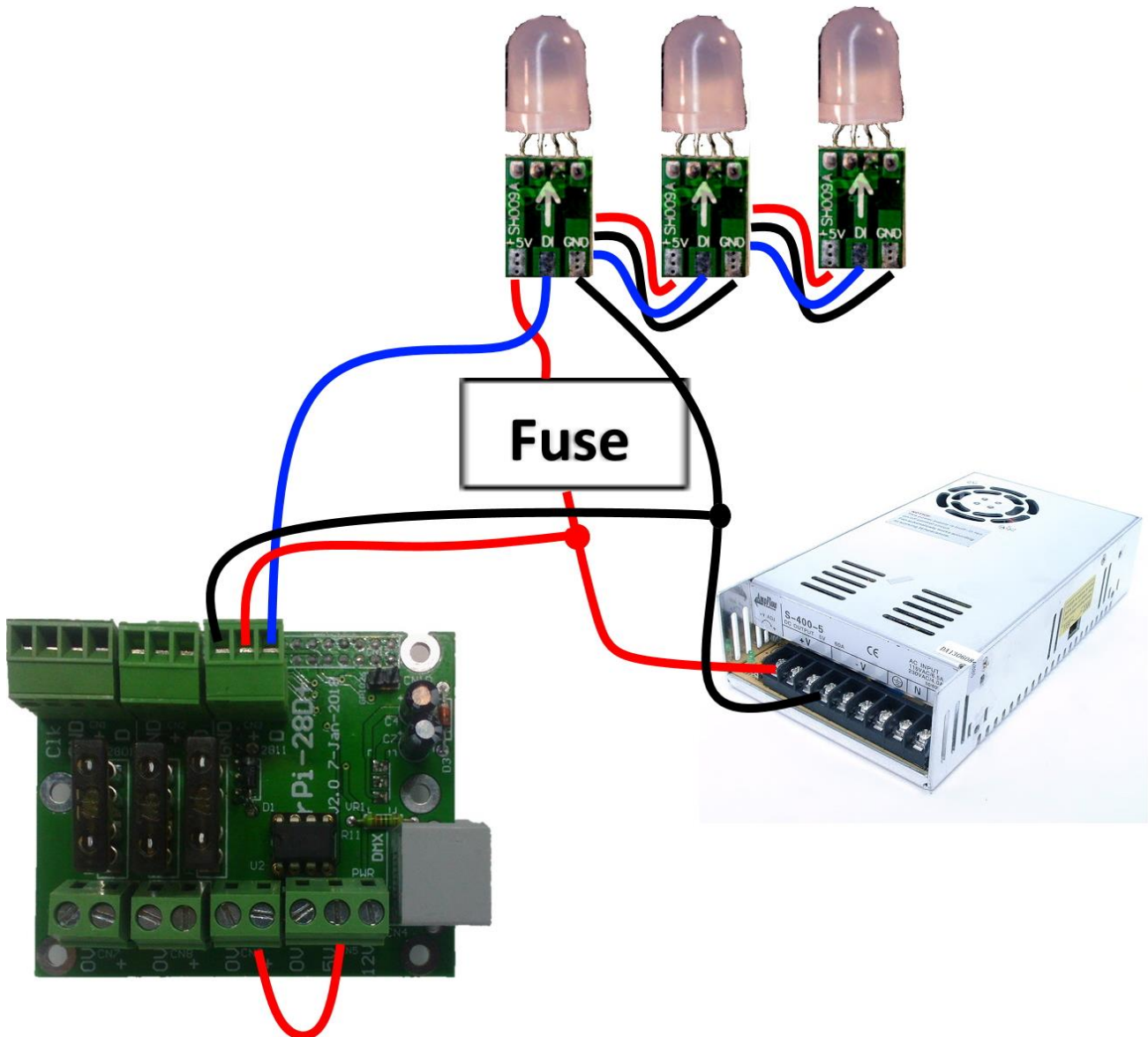
One pixel power supply is shown but depending on the pixel voltage/s more than 1 may be required. It is possible to mix between powering through the rPi-28D+ and powering external to it.

The power for the rPi-28D+ is not shown.



Power supply connections showing how the board and pixels are connected if powering pixels through the rPi-28D+. If this method is used then up to 150 pixels (at 100% brightness) can be powered through the board. Power injection may be required depending on pixel wiring. The power for the pcb is not shown connected to the 5V or 12V input. It connects to the 1 that matches the power supply voltage. If 5V then a 2A fuse should be used. If 12V then a 1A fuse should be used.

Powering rPi-28D+ from pixels



One pixel power supply and string is shown. This method of powering the rPi-28D+ can be used on any 1 of the 3 pixel outputs. The power wiring between pixel string and rPi-28D+ needs to be sufficient to handle the 1A for 12V or 2A for 5V that the board requires. For 5V extra care in cable size needs to be taken as a voltage drop of more than about 100mV may render Pi inoperable.

The power for the pcb is shown connected to the 5V power input. It connects to the 1 that matches the power supply voltage. If 5V then a 2A fuse should be used. If 12V then a 1A fuse should be used.

Alternately the 1A or 2A fuse can be mounted at the pixel/power supply end.

GPIO Input

There is a GPIO input available on CN10 which connects to Pi GPIO26, (pin 37 of Pi header). This input can be used to trigger scripts. The input will need a pullup enabled via the GPIO setup and connection to the input should be via a voltage free contact ie a switch or relay contact. The Enable (En.) needs to be ticked to enable the use of the input.

En.	Hdr - Pin	GPIO # - GPIO D	Pull Up/Down	Commands	
				Rising Edge	Falling Edge
<input type="checkbox"/>	P1-35	19 - 0/19	None/External	Command: <input type="text"/>	Command: <input type="text"/>
<input type="checkbox"/>	P1-36	16 - 0/16	None/External	Command: <input type="text"/>	Command: <input type="text"/>
<input type="checkbox"/>	P1-37	26 - 0/26	None/External	Command: <input type="text"/>	Command: <input type="text"/>
<input type="checkbox"/>	P1-38	20 - 0/20	None/External	Command: <input type="text"/>	Command: <input type="text"/>
<input type="checkbox"/>	P1-40	21 - 0/21	None/External	Command: <input type="text"/>	Command: <input type="text"/>

DMX output

The RS485 output of the rPi-28D+ is wired according to the ESTA pinout with pin 1 being Data +, pin 2 being Data- and pins 7 and 8 being gnd. It's possible in the FPP setup to configure the data type as DMX, LOR or Renard. It will be necessary to use an adaptor or crossover cable to connect to these other style of controller. The RS485 driver IC is in an IC socket and can be easily replaced if damaged. The DMX output is not electrically isolated from the Pi.

#	Active	Output Type	Start Ch.	Channel Count	Output Config
1	<input type="checkbox"/>	DMX-Open	1	512	Port: ttyAMA0

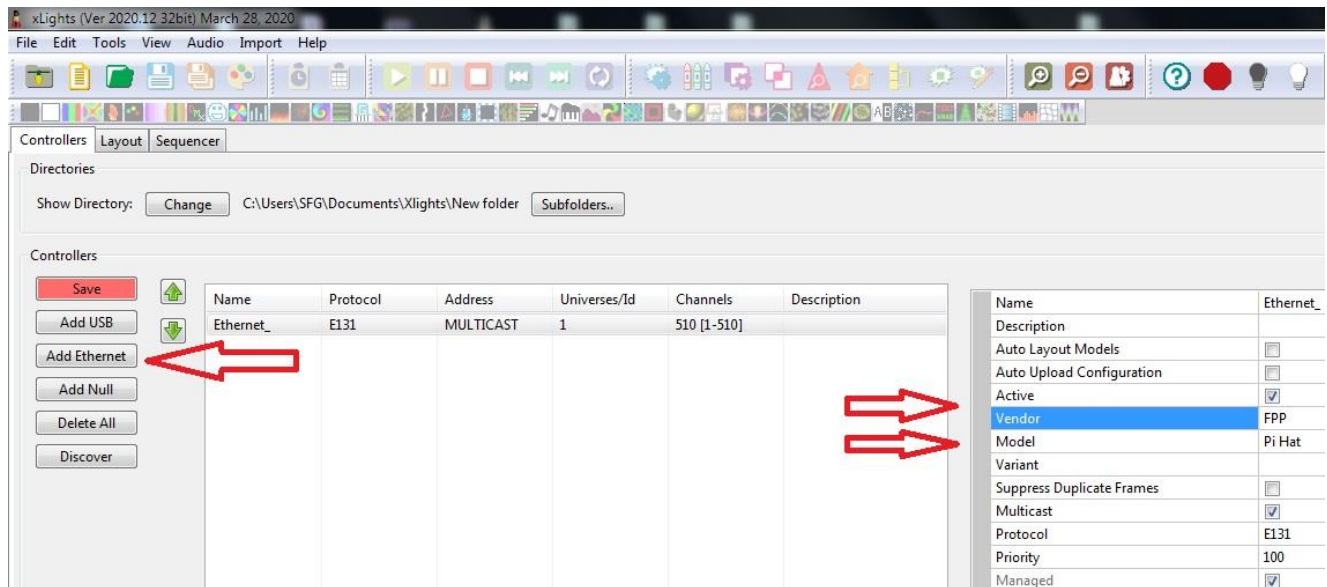
The “Act” checkbox must be ticked to enable the output.

WS2801 Output

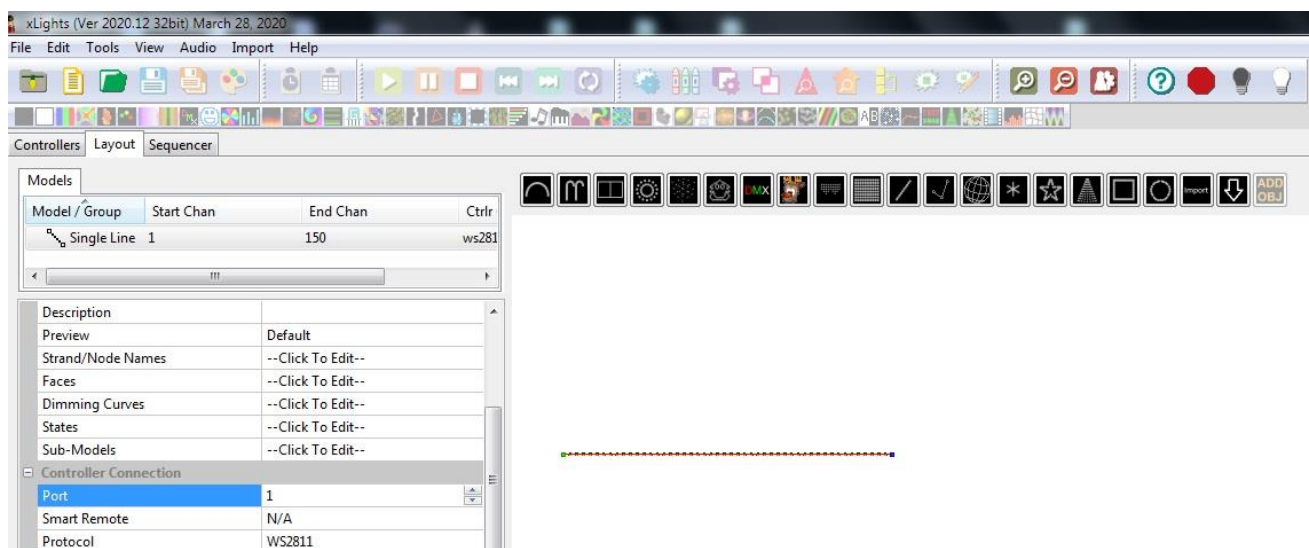
The WS2801 output CN1 (Pwr CN7) is configured as type “SPI-WS2801” and the port is “spidev0.1”

Xlights configuration and FPP Connect

The full configuration of Xlights to suit the rPi-28D+ is beyond the scope of this manual. An abbreviated setup is shown. The screenshots only apply to 2020 and later versions of Xlights.



The rPi-28D+ is configured as an Ethernet controller, FPP device under Vendors and the model is a PiHat



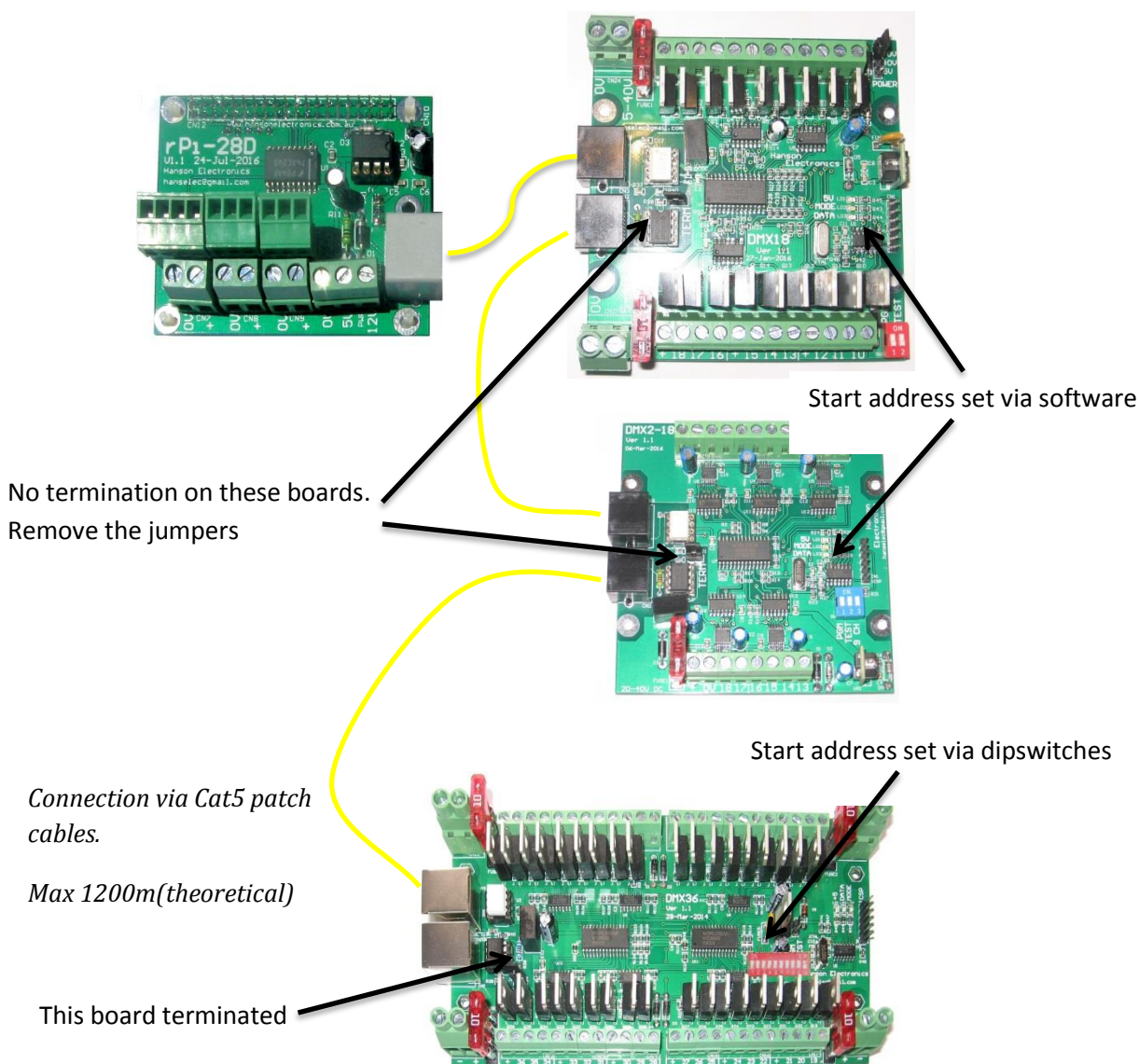
When configuring models on the Layout tab the pixel outputs will be on Ports 1 and 2, there is no Smart Remote, Protocol is WS2811. For DMX props the port is number 3 and the protocol is DMX-Open .

Connecting DMX boards/devices

DMX is an implementation of an RS485 network. It is commonly connected via Cat5 or Cat6 RJ45 patch cables or 3 core cable with 3 pin or 5 pin Cannon connectors when used for stage equipment. The normal method of connection is from a data source daisy chained from controller to controller before the final board is terminated either via an onboard termination or via a connector with a 120 Ohm resistor in it.

In general most DMX boards will have 2 DMX connectors. These are connected directly in parallel and it doesn't matter which is used for the data in and which is used for the data out. There are 2 exceptions to this general rule. Some cheap Chinese DMX modules only have a single point to connect the DMX data too and it is necessary to tee off at that point to other boards. The other exception is some stage type DMX devices that have a Master and a Slave connector. This is because there is internal electronics that allow the device to generate effects that can be sent downstream to other devices.

All devices on a DMX cable are on the same DMX universe and that is configured on whatever is sending out the data, not on the devices. All DMX devices have a "start address". This is the 1st address that the device uses and it will use that address and the next "n" data bytes. The cabling order of DMX devices doesn't matter. The only requirement is that the final device is terminated to prevent data issues. Terminating any other device is likely to cause data reliability issues.



Enquiries/Repairs :-

Hanson Electronics

Alan Hanson

16 York St

Eaglehawk, Victoria, Australia 3556

Mobile 0408 463295 International +61408 463295

email hanselec @ gmail.com

web www.hansonelectronics.com.au

Facebook www.facebook.com/HansonElectronicsAustralia