

Raspberry Pi 3 B+/4 B and JMRI with WiFi Access Point for Pi-SPROG One and Pi-SPROG Nano

2020-02-13-raspbian-buster build

June 2020 © SPROG DCC

These instructions describe the process of setting up a Raspberry Pi 3 Model B+ or Raspberry Pi 4 Model B as a WiFi access point (AP) for connection by hand-held devices running WiThrottle, EngineDriver or other similar apps. The use of an up to date Windows 10 installation is assumed.

If you have downloaded or purchased the image on SD card from SPROG DCC then you do not need these instructions, other than for reference.

Some familiarity with the Raspberry Pi and Linux operating system is assumed, especially the use of the command line in a terminal and simple editors such as vi or nano.

Where we say “we like...” in the following instructions, we indicate how our SPROG DCC pre-built card images are made. These steps can be tailored by more advanced users to your own preference.

Rather than using a wired Ethernet connection and PuTTY for the initial setup, it should be possible to do the setup locally on the R-Pi by attaching a USB keyboard, mouse and a HDMI display.

These instructions should be generally applicable to the Buster distribution on other Raspberry Pi hardware.

Bold Consolas font text indicates text that is typed at the R-Pi command line in an SSH shell, or a desktop terminal window.

Indented Bold Consolas font text indicates text that is entered in text editor.

Hardware Requirements

Raspberry Pi 3 model B+ or Raspberry Pi 4 Model B and suitable power supply.

MicroSD memory card (8Gb recommended)

Pi-SPROG One and power supply

Host PC (Windows or Linux)

Wired network connection from the R-Pi to your router during setup and if you require network (e.g. internet) access whilst using the R-Pi as an Access Point.

Software Requirements

SSH client installed on the host. These instructions assume the use of putty.exe

<http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html> on Windows.

VNC Viewer installed on the host, <https://www.realvnc.com/download/viewer/>

Create the SD Card Image

Start with the latest Raspbian Buster image (2020-02-13 at the time of writing) installed on an SD card. See <https://www.raspberrypi.org/documentation/installation/installing-images/README.md> To keep the image size as small as possible we use the “Raspbian Buster with Desktop” image. These instructions should also work with the “Raspbian Buster with Desktop and recommended software” image if you also require the recommended software.

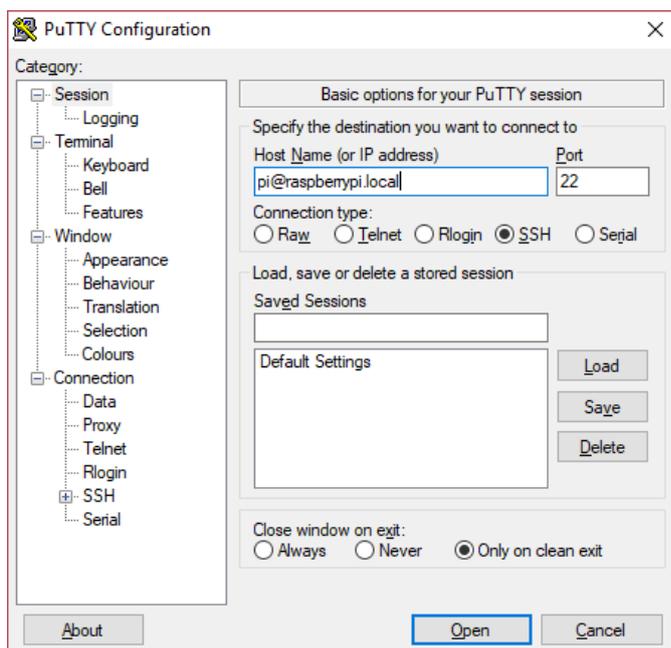
Create a file named ssh in the boot partition so that SSH will be enabled on the R-Pi. With a windows host do this by viewing the contents of the SD card in Windows Explorer, right click, New Text Document and change the name to ssh. This step must be performed before the first boot and will enable SSH and allow you to proceed to the next step.

Put the SD card in the R-Pi’s SD card slot, connect the R-Pi to your home network via the wired ethernet port and connect power to the R-Pi.

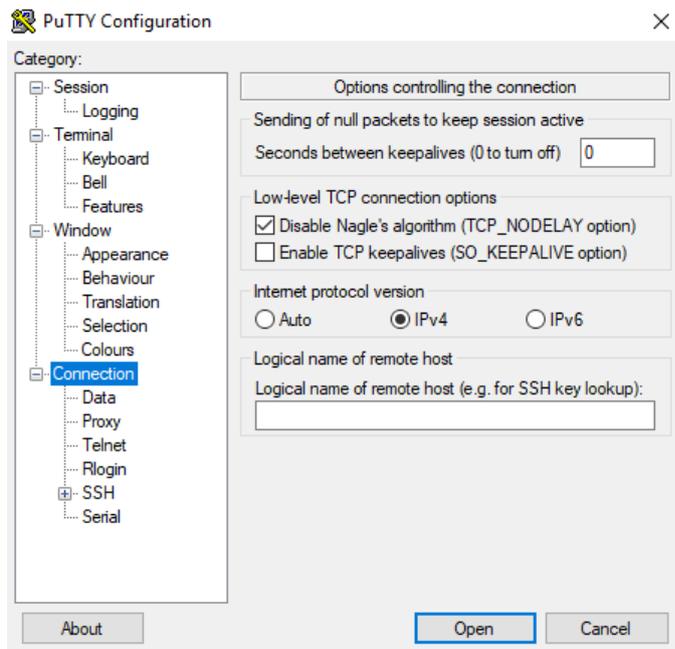
Connecting With SSH

Using PuTTY (or your chosen SSH client) connect and login using the default user name and hostname pi@raspberrypi.local

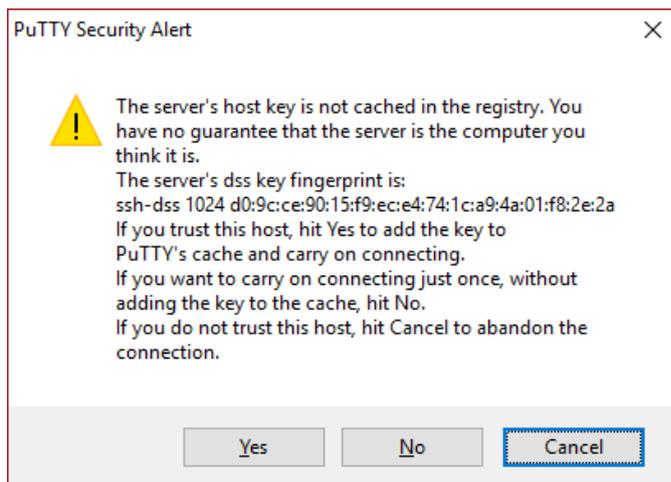
If the following procedure does not work (can happen on Windows 10 hosts) determine the R-Pi’s IP address (from your router) and use that in place of the hostname, e.g. pi@192.168.1.10



On Windows 10 ensure the internet protocol version is set to ipv4



Click Open to connects and click Yes if presented with a security alert.



When prompted enter the password 'raspberrypi'



```
pi@raspberrypi: ~
Using username "pi".
pi@raspberrypi.local's password:
Linux raspberrypi 4.14.30-v7+ #1102 SMP Mon Mar 26 16:45:49 BST 2018 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue Apr 17 18:53:37 2018

SSH is enabled and the default password for the 'pi' user has not been changed.
This is a security risk - please login as the 'pi' user and type 'passwd' to set
a new password.

Wi-Fi is disabled because the country is not set.
Use raspi-config to set the country before use.

pi@raspberrypi:~ $
```

Note the warning message "SSH is enabled ..."

You may wish to change the password before proceeding, especially if you intend making your R-Pi visible on the Internet. Be sure to remember the new password.

Ensure you have the latest updates.

sudo apt-get update

and then

sudo apt-get dist-upgrade

The updates may take a little time. Answer Y if prompted to continue.

Update R-Pi 4 Firmware

You may want to update the firmware on your R-Pi 4, depending when it was purchased, in order to get the latest power saving features.

sudo apt install rpi-eeprom

sudo rpi-eeprom-update

If you see something like ***** UPDATE REQUIRED ***** then run the command with the **-a** switch

sudo rpi-eeprom-update -a

Reboot

Reboot your R-Pi.

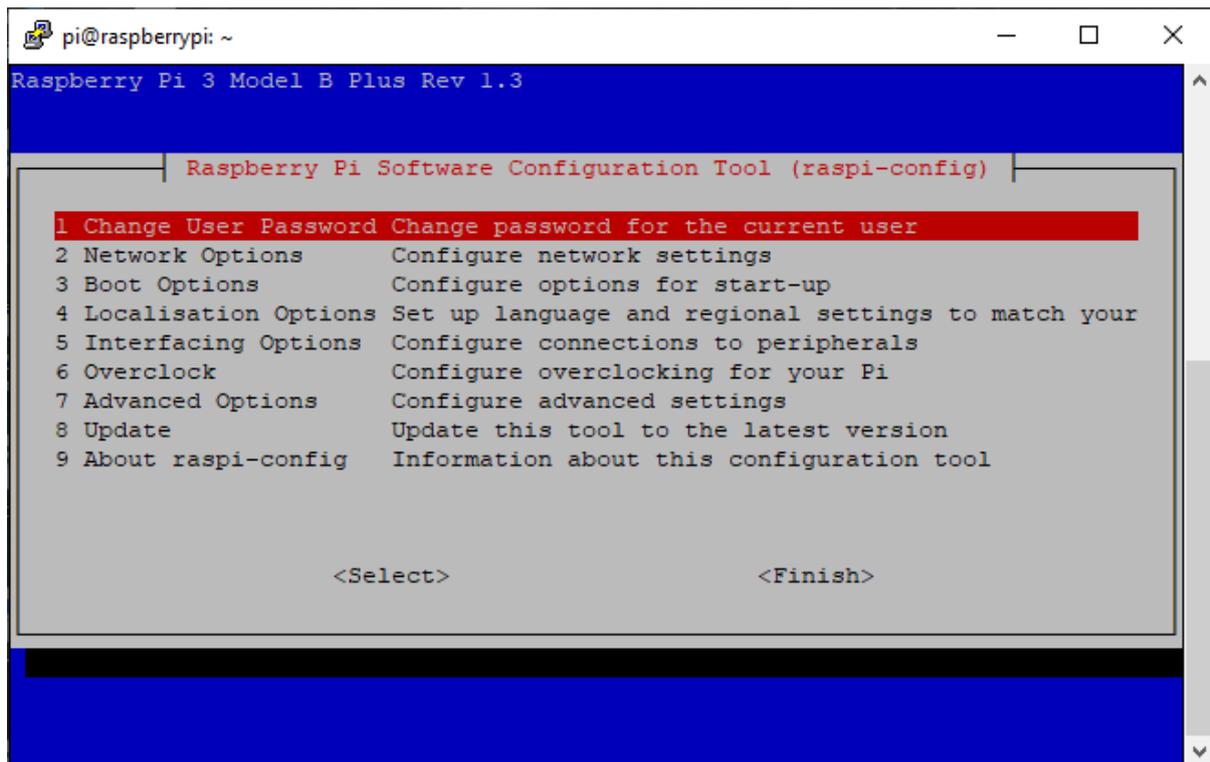
sudo reboot

Close the PuTTY window and then reconnect (with PuTTY) once the R-Pi has rebooted.

Run raspi-config

To allow remote access to the virtual desktop, rather than the SSH command line, we need to enable VNC which is included with the Raspian distribution. Use the raspi-config utility.

sudo raspi-config



Use the cursor keys to select Interfacing Options and enable VNC.

Return to the main raspi-config screen and select Localization options

Select Change WiFi Country and then select your country, e.g. GB for Great Britain.

Return to the main raspi-config screen and select Advanced options.

Select Resolution.

Select your chosen screen resolution for the virtual desktop, e.g., DMT Mode 85 1280x720 for a small window on the host PC. Choose a larger resolution if you prefer. You can change the resolution at any time from the virtual desktop once you have connected with VNC.

Exit raspi-config, do not reboot just yet.

Set UART Overlay

We require the UART interfaces to be swapped for the Pi-SPROG One so that serial0 is routed to the GPIO connector instead of being used for BlueTooth. This is done by adding an overlay to config.txt.

```
sudo nano /boot/config.txt
```

Scroll to the end of the file and add the following lines:

```
dtoverlay=pi3-miniuart-bt
enable_uart=1
```

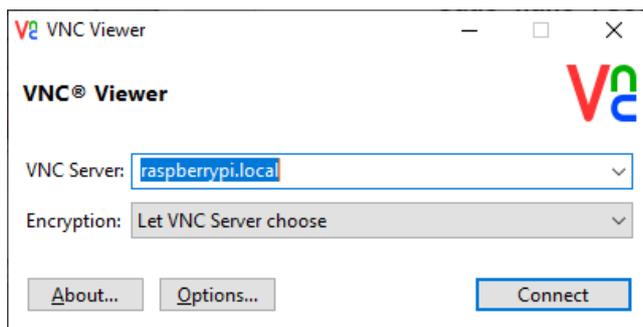
Save (Write Out) the file and Exit.

Reboot your R-Pi.

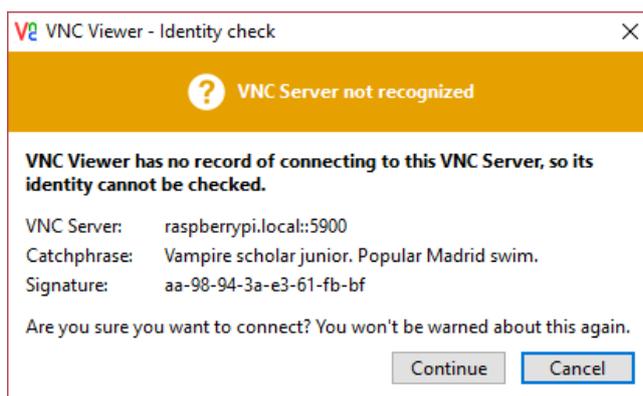
Close the PuTTY window.

Connecting With VNC

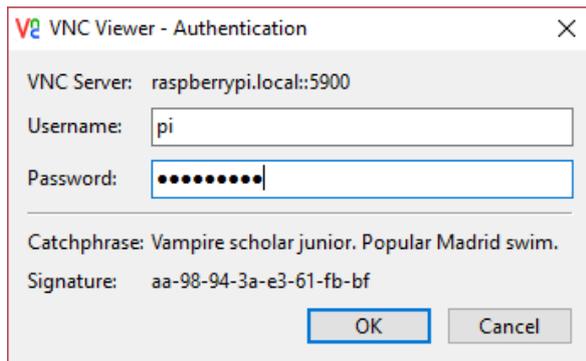
Start VNC viewer on the host PC. Enter the VNC Server name 'raspberrypi.local' and click Connect.



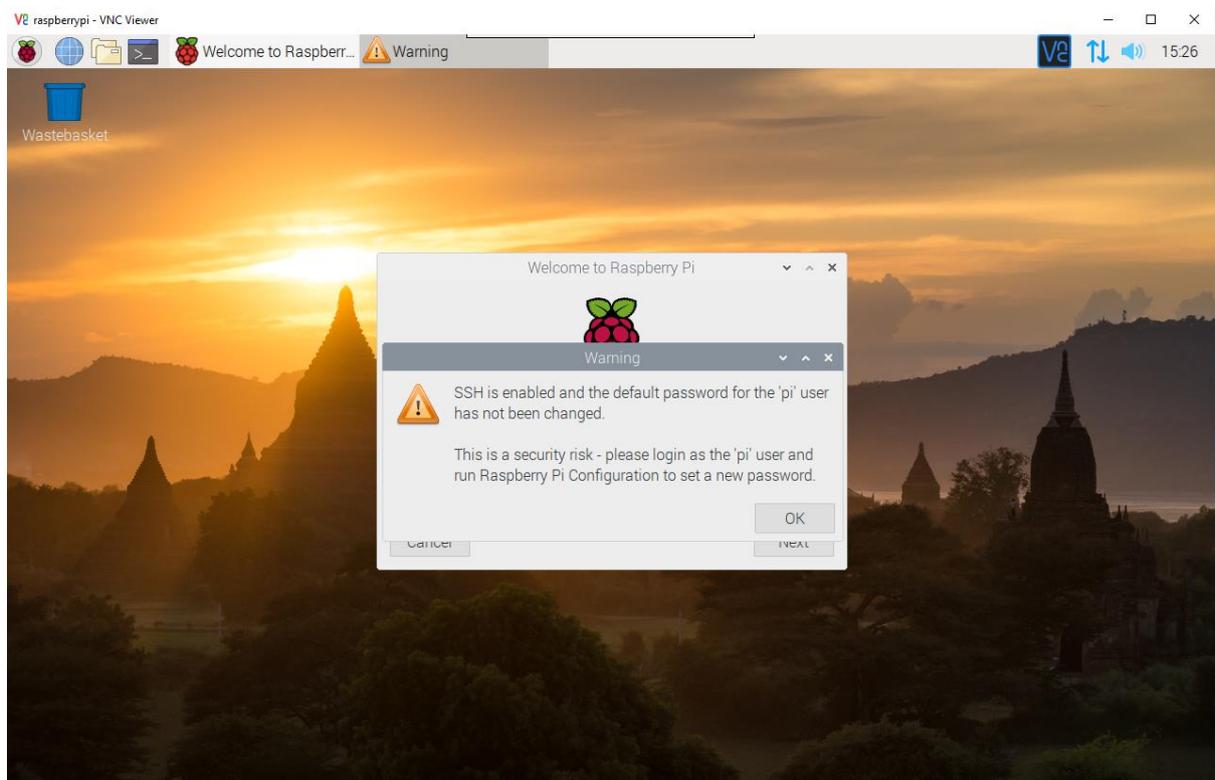
The first time you connect you will see an identity check



Click Continue, then enter the default username (pi) and password (default: raspberry, or the password you chose earlier)



If you have not changed the default password, you will see a warning message each time you connect

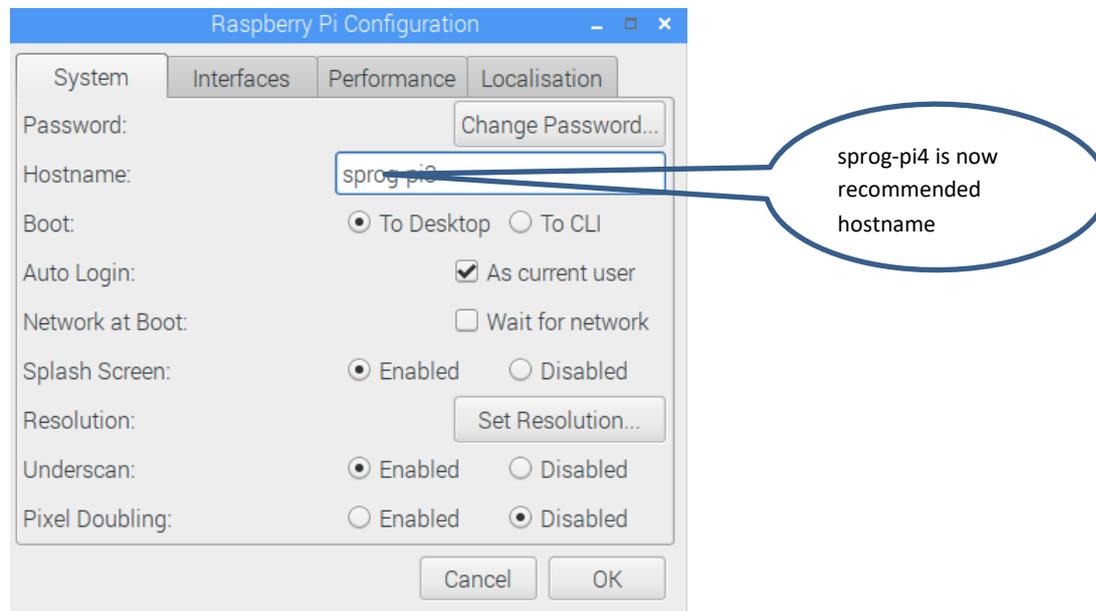


Click OK.

Click Next in the Welcome window and step through the one-time setup. **Do not** attempt to connect to a Wireless network, click Skip at that stage. You have another opportunity to change the default password should you wish to do so. Be sure to remember it! Click Skip at the Update Software Stage.

R-Pi Configuration

Click the Raspberry logo at the top left of the screen and select Preferences -> Raspberry Pi Configuration



Change the Hostname (optional, useful if you have more than one R-Pi). We use sprog-pi4 for our images. If you change it, then this is the name you must use in future for SSH and VNC, e.g. sprog-pi4.local, rather than raspberrypi.local, in our case.

Click OK, then click No to postpone the reboot.

Additional UART setup

Edit the command line to prevent the Kernel using the UART at startup. Open a terminal window.

```
sudo nano /boot/cmdline.txt
```

Remove 'console=serial0,115200' noting that this file must contain only one line. Be careful not to split the line when editing it.

Save (Write out) the file and quit the editor.

Reboot your R-Pi (Raspberry Pi logo -> Shutdown -> Reboot). Close the VNC window.

Wait a few moments for the R-Pi to reboot. Reconnect with VNC using the new hostname and/or password (if you changed them) in the previous step.

Check that the UARTs are mapped correctly, open a terminal and type

```
ls -l /dev/ser*
```

The output should be something like

```
lrwxrwxrwx 1 root root 5 Dec 13 13:34 /dev/serial0 -> ttyAMA0
lrwxrwxrwx 1 root root 5 Dec 13 13:34 /dev/serial1 -> ttyS0
```

Download and Install Java

The “Raspian Buster with Desktop” image does not include Java. Skip this step if you started from the “Raspian Buster with Desktop and recommended software” image.

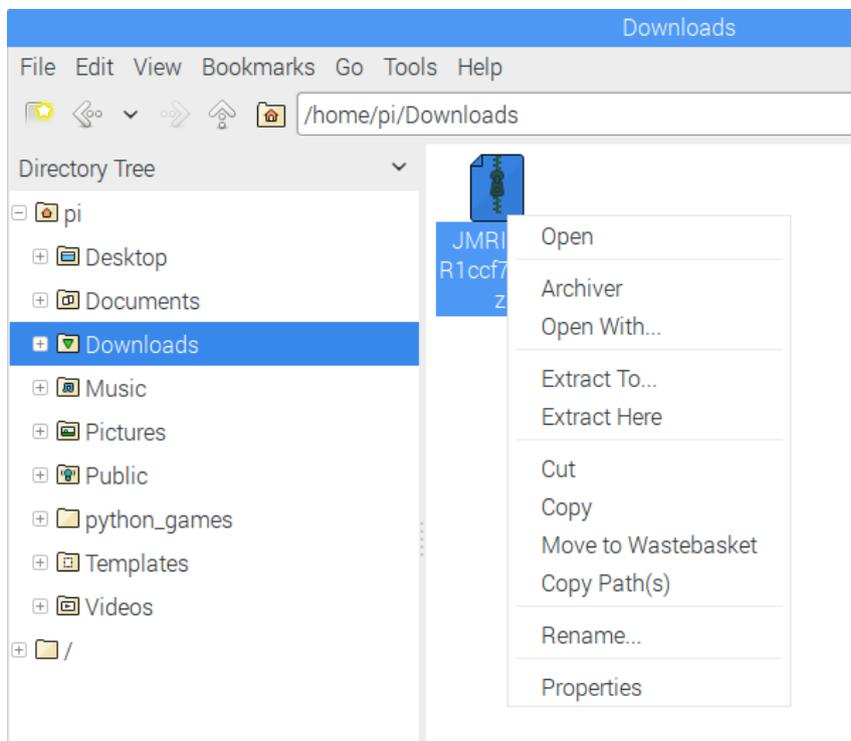
Open a terminal and type

```
sudo apt-get install -y openjdk-11-jre
```

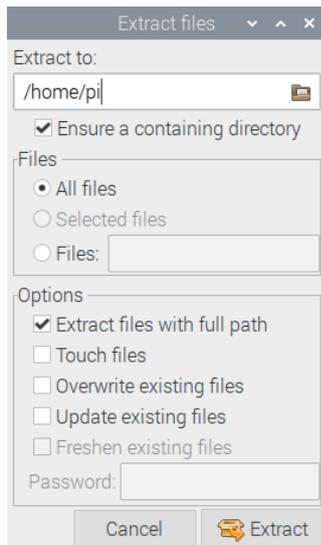
Download and Install JMRI

Using the R-Pi web browser, navigate to www.jmri.org/download/index.shtml or search for ‘jmri downloads’ and download your chosen JMRI version for Linux (.tgz file). We strongly recommend you download JMRI 4.18 or later if using the Pi-SPROG One as a command station.

When the download is complete, open the Downloads folder in File Manager, right click the downloaded archive and Extract To... (may take a little while to open the archive).



Browse to, or type, your chosen location for installing JMRI, e.g., /home/pi, select “Ensure a containing directory”. Click Extract.



If extracted to /home/pi then the path to the application will be /home/pi/JMRI which we use in the following instructions.

We will now create Desktop icons to allow to run either PanelPro for layout control with the Pi-SPROG One in Command Station mode, or DecoderPro for decoder programming using a programming track with the Pi-SPROG One in programmer mode.

Create a Desktop Icon for PanelPro

In a terminal window create and edit a desktop shortcut.

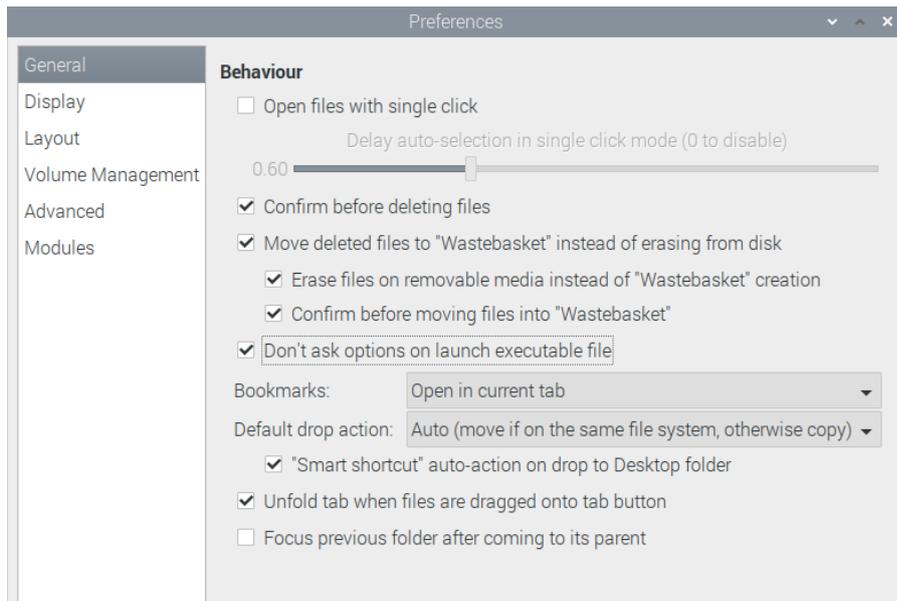
```
sudo nano /home/pi/Desktop/PanelPro.desktop
```

```
[Desktop Entry]
Type=Application
Encoding=UTF-8
Name=PanelPro
Comment=JMRI PanelPro
Icon=/home/pi/JMRI/resources/PanelPro.gif
Exec=/home/pi/JMRI/PanelPro
Terminal=false;
```

Adjust the paths as appropriate, depending where you extracted JMRI in the previous step.

Save the file and quit the editor.

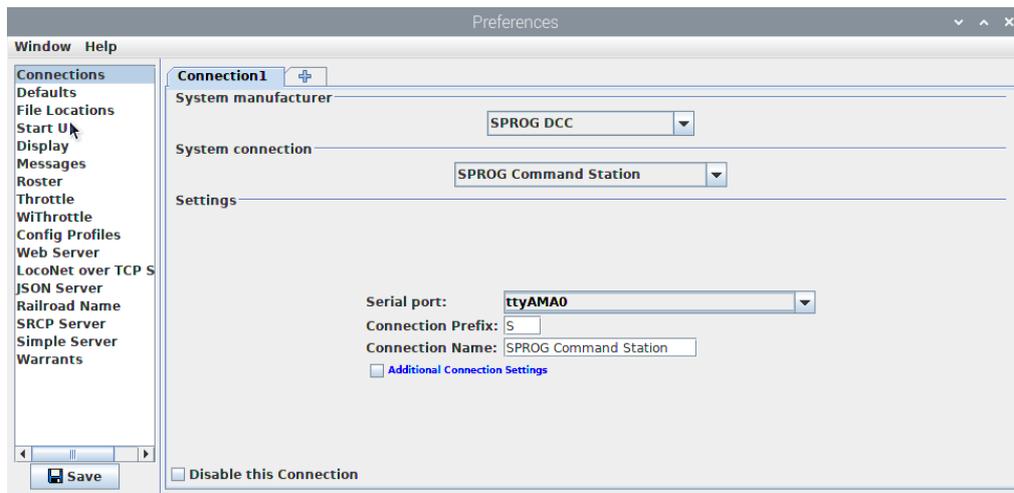
Open the File Manager and edit preferences select “Don’t ask options on launch executable file”



Close the File Manager.

Start PanelPro by double clicking the new desktop icon.

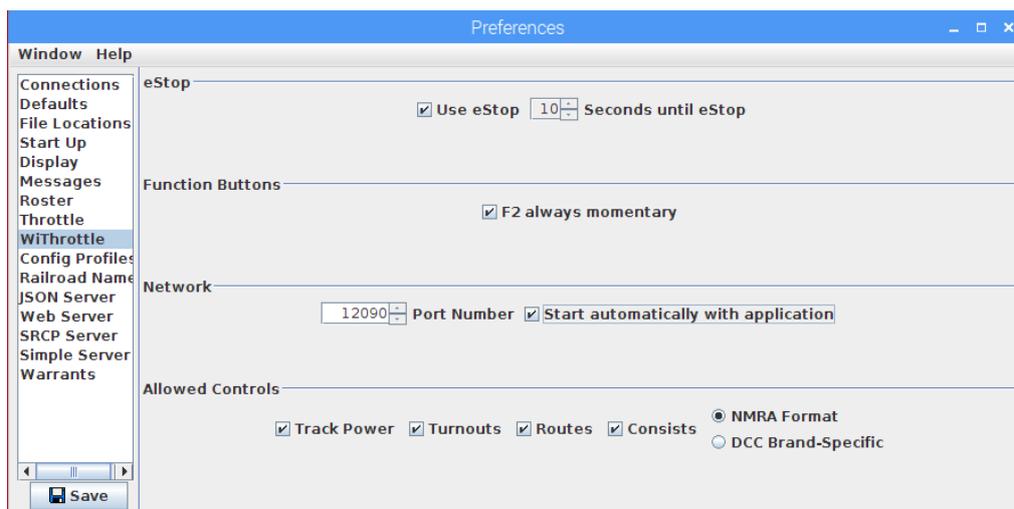
When the Preferences appears, create a new profile by selecting SPROG DCC as the System and Pi-SPROG One Command Station as the System connection. Select ttyAMA0 as the Serial port.



Keep the Preferences open for the next step.

Start Withrottle Server Automatically

Select WiThrottle, Start automatically with application on port 12090.



Save the preferences and restart PanelPro. The WiThrottle server should start up (may be hidden behind the PanelPro window).

Quit PanelPro.

Create a Desktop Icon for DecoderPro

```
cp /home/pi/Desktop/PanelPro.desktop /home/pi/Desktop/DecoderPro.desktop
```

Edit the new shortcut to run DecoderPro instead of PanelPro, by changing the lines shown:

```
sudo nano /home/pi/Desktop/DecoderPro.desktop
```

```
Name=DecoderPro
Comment=JMRI DecoderPro
```

```
Icon=/home/pi/JMRI/resources/dp3_48x48.gif
Exec=/home/pi/JMRI/DecoderPro
```

Save the file and quit the editor.

Start DecoderPro and click New when the Profile selector appears.

Give the Profile a name, e.g. DecoderPro-Pi-SPROG and click OK.

Click OK.

Work through the connection wizard and set the same preferences as you did for PanelPro but select Pi SPROG One Programmer as the System connection and do not enable the WiThrottle server.

Quit DecoderPro.

Run PanelPro (or DecoderPro) at Startup (optional)

You must only try to run one of PanelPro or DecoderPro at any one time, otherwise there will be a conflict of access to the serial port.

Complete this step if you want the software to start automatically at startup. E.g., to start PanelPro with the WiThrottle server if you do not have a screen and keyboard connected to the Pi.sud

In a terminal create a session autostart file

```
sudo mkdir .config/lxsession
sudo mkdir .config/lxsession/LXDE-pi
sudo cp /etc/xdg/lxsession/LXDE-pi/autostart .config/lxsession/LXDE-pi/
sudo nano /home/pi/.config/lxsession/LXDE-pi/autostart
```

Add the following line, with the path to the location where you installed PanelPro (or DecoderPro)

```
@/home/pi/JMRI/PanelPro
```

Save the file and quit the editor.

WiFi Access Point (AP) Setup

For reference, these instructions in this section are based on

<https://www.raspberrypi.org/documentation/configuration/wireless/access-point.md> with our own customization.

Download and install DNS and AP software packages:

```
sudo apt-get install -y dnsmasq hostapd
```

Turn the newly installed software off whilst we edit the configuration files:

```
sudo systemctl stop dnsmasq
sudo systemctl stop hostapd
```

Apply Static IP Address to the R-Pi

Edit the interface settings to set a static IP address for your R-Pi wireless network. First, prevent dhcpd managing the WiFi network. Add the following lines to the end of the configuration file:

```
sudo nano /etc/dhcpd.conf

    interface wlan0
    static ip_address=192.168.6.1/24
```

Write the file and quit the editor.

Restart dhcpd

```
sudo service dhcpd restart
```

Configure dnsmasq

Save the old configuration.

```
sudo mv /etc/dnsmasq.conf /etc/dnsmasq.conf.orig
```

Create a new one by entering the following in your editor.

```
sudo nano /etc/dnsmasq.conf

    interface=wlan0
    domain-needed
    dhcp-range=192.168.6.50,192.168.6.99,255.255.255.0,12h
    dhcp-option=252,"\n"
```

Save the file and quite the editor.

The dhcp-range should be in the same subnet as the static IP assigned to the R-Pi. In our example the R-Pi was assigned the static IP address 192.168.6.1. The dhcp-range example here is in the same 192.168.6.x subnet and will assign up to 50 IP addresses to WiFi connected devices in the range 192.168.6.50 - 192.168.6.99.

Configure the AP

Configure hostapd by creating a configuration file with your editor. The ssid can be the same as the hostname setup above.

Note the driver name is "en-el-eight-zero-two-one-one" .

You may wish to use a different wireless channel depending on which channels are less congested in your situation.

You may choose your own passphrase (password), but be sure to remember it. The password must be at least 8 characters.

```
sudo nano /etc/hostapd/hostapd.conf
```

```
interface=wlan0
driver=nl80211
ssid=sprog-pi4
hw_mode=g
channel=6
ieee80211n=1
wmm_enabled=1
ht_capab=[HT40][SHORT-GI-20][DSSS_CCK-40]
macaddr_acl=0
auth_algs=3
ignore_broadcast_ssid=0
wpa=3
wpa_key_mgmt=WPA-PSK
wpa_passphrase=pi-sprog
wpa_pairwise=TKIP
rsn_pairwise=CCMP
eap_reauth_period=360000000
```

Write the file and quit the editor.

Next, tell hostapd where to look for the config file when it starts up on boot;

```
sudo nano /etc/default/hostapd
```

Uncomment (remove the leading # character) the DAEMON_CONF line and enter the path to .conf file you just created.

```
DAEMON_CONF="/etc/hostapd/hostapd.conf"
```

Save the file and quit the editor.

Workaround for WiFi Timing Issue

There seems to be an issue with the WiFi Access Point startup on R-Pi 3 B+. Sometimes the AP will not be visible in the device you want to connect. The recommendation from the RPi forum is to add the following to /etc/rc.local just before the "exit 0"

```
service hostapd stop

sleep 5

service hostapd start
```

Start the services

```
sudo systemctl unmask hostapd
```

```
sudo systemctl enable hostapd
```

```
sudo systemctl start hostapd
```

```
sudo systemctl start dnsmasq
```

Reboot your R-Pi.

You should now be able to connect to the sprog-pi4 network and be assigned an IP address. You may receive a notification that there is no internet connection.

WiThrottle or EngineDriver apps should now be able to connect to the WiThrottle server in JMRI.

If you cannot find the sprog-pi4 wireless network, check the status of hostapd

```
sudo service hostapd status
```

It should show active (running).

If it shows active (exited) then you have a problem with /etc/default/hostapd with the DAEMON_CONF variable or a problem with /etc/hostapd/hostapd.conf.

Type CTRL-C to exit the status.

You may also connect to the R-Pi from, e.g., a laptop or tablet by selecting the sprog-pi3 network in the wireless network setup. Login with the WPA passphrase, entered above, as you would when connecting to your own wireless router. Run VNC viewer, or similar, on your laptop or tablet to see the R-Pi desktop.

The setup presented here does not allow wireless devices connected to the R-Pi to access the wired connection (e.g., to access the internet). This is intended as a security measure. More advanced users can perform further configuration (not covered here) to allow forwarding.

Make a Backup

Once everything is working, we strongly suggest you make a backup copy of your SD card.

Caring for your SD Card

To avoid the possibility of data corruption on the SD card, you should always perform a clean shutdown of the R-Pi before removing power. If you do not have access to the virtual desktop then this can be done remotely from the device you use as a throttle, e.g. for Android we recommend the SSH button app. Configure it with the host name, user and password and send the command 'sudo shutdown -h now'.

Updating JMRI

Follow the earlier instructions for installing JMRI if you wish to download and install a newer release. You may wish to create a backup image of your SD card before doing so.