

Raspberry Pi 3 B+/4 B and JMRI with WiFi Access Point for Pi-SPROG 3, Pi-SPROG 3 v2 and Pi-SPROG 3 Plus 2021-10-30-raspbios-bullseye build

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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, as well as other Buster releases.

Unless explicitly stated, references to Pi-SPROG 3 can be taken as also applying to the Pi-SPROG 3 Plus and Pi-SPROG 3 v2.

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, or larger, recommended)

Pi-SPROG 3 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 PC. 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 2021-10-30-raspbros-bullseye image installed on an SD card, but do not insert it into your Raspberry Pi just yet. See <https://www.raspberrypi.org/documentation/installation/installing-images/README.md> To keep the image size as small as possible we use the “Raspian Buster with Desktop” image. These instructions should also work with the “Raspian Buster with Desktop and recommended software” image if you also require the recommended software. The latter will result in a larger image but it will still fit on an 8 GB SD Card.

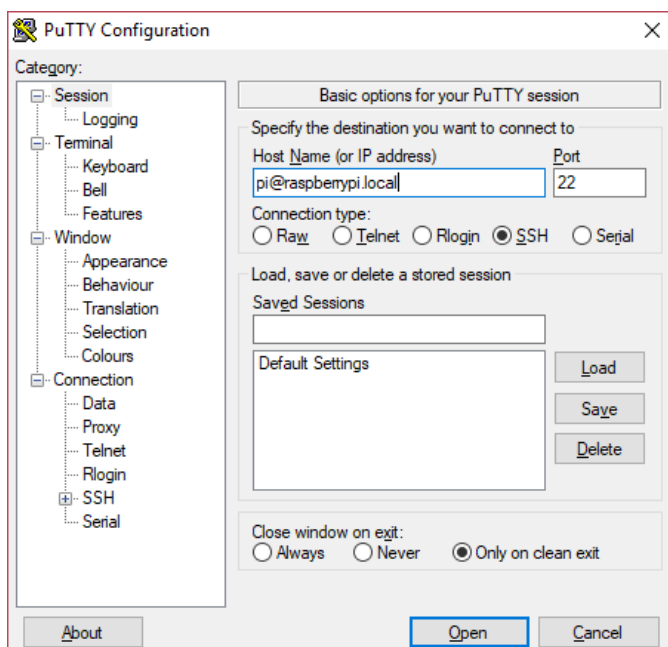
Create a file named ssh in the boot partition of the SD card so that SSH will be enabled on the R-Pi. With a Windows host do this by viewing the contents of the SD card in Windows Explorer, right click, New Text Document and change the name to ssh (removing the .txt extension). This step must be performed 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.

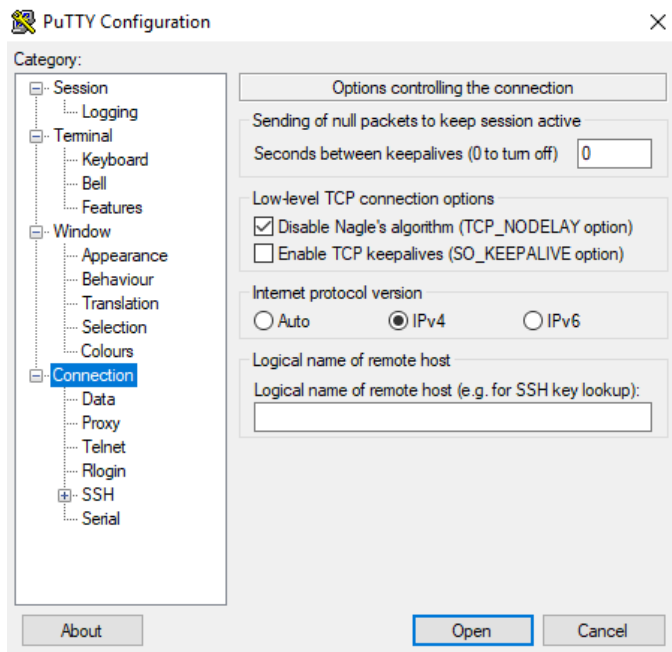
Connecting With SSH

Using PuTTY (or your chosen SSH client) connect and login using the default user name and hostname [pi@raspberrypi.local](https://www.raspberrypi.org/documentation/remote-access/ssh/quickstart.md)

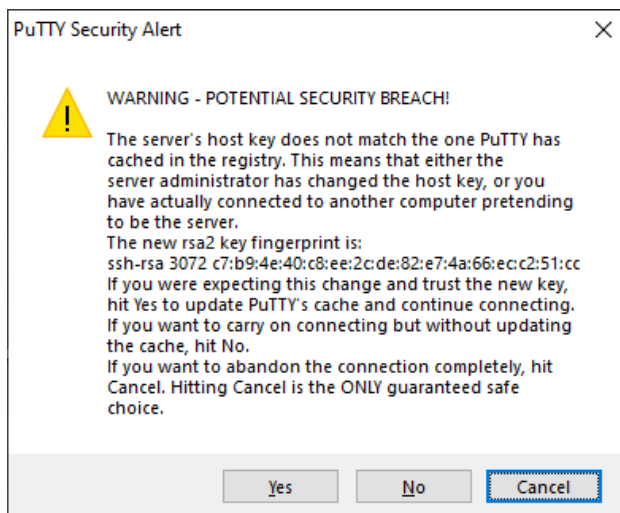
If the following procedure does not work (can happen on Windows 10 hosts) try pi@raspberrypi and if that does not work determine the R-Pi’s IP address (from your router) and use that in place of the hostname, e.g. pi@192.168.1.19



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 package update list.

sudo apt-get update

and then install updates

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 rpi-eeprom-update

If you see something like ***** UPDATE REQUIRED ***** or ***** UPDATE AVAILABLE ***** then run the command with the **-a** switch if you wish to install the update.

sudo rpi-eeprom-update -a

Reboot

Reboot your R-Pi.

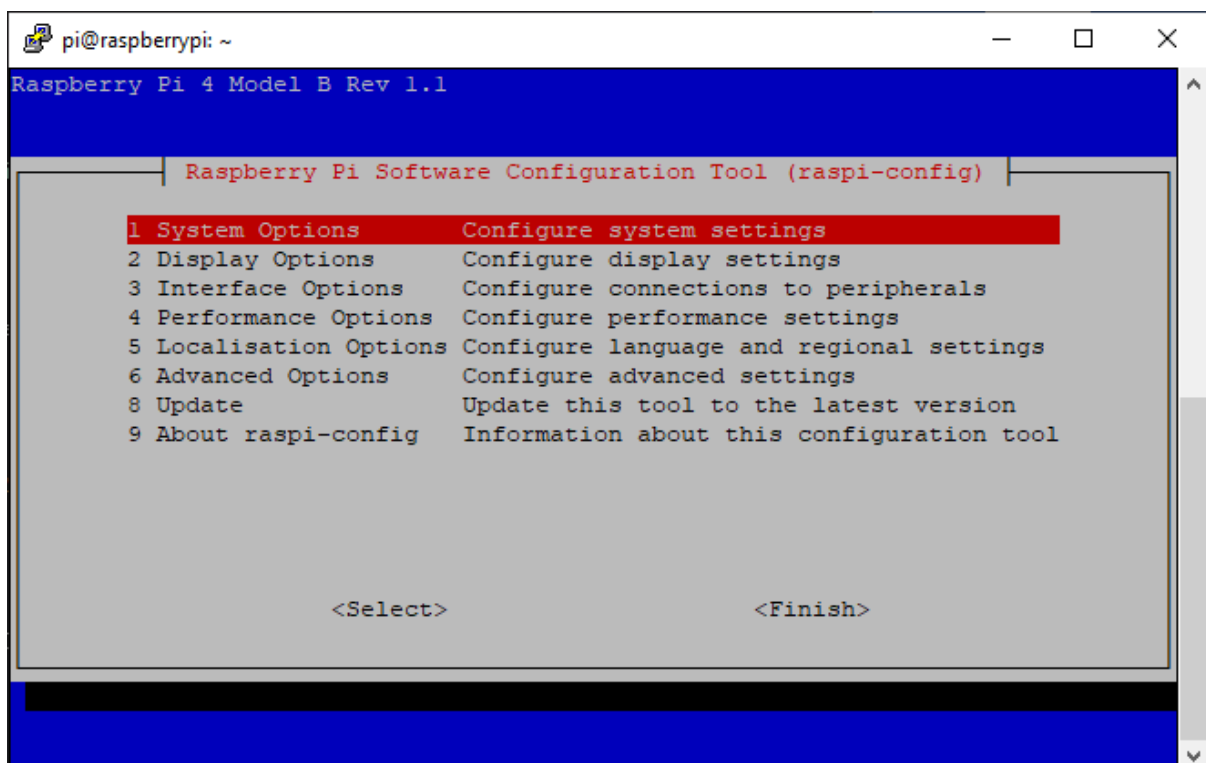
sudo reboot

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 Raspios 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 WLAN Country and then select your country, e.g., GB for Great Britain.

Return to the main raspi-config screen and select Display Options.

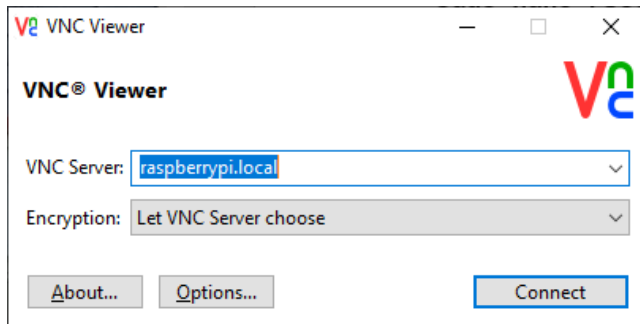
Select VNC Resolution.

Select your chosen screen size for the virtual desktop. You may wish to select a size to match the full screen resolution of your host PC, or a smaller window. You can change the resolution at any time from the virtual desktop once you have connected with VNC.

Exit raspi-config and reboot.

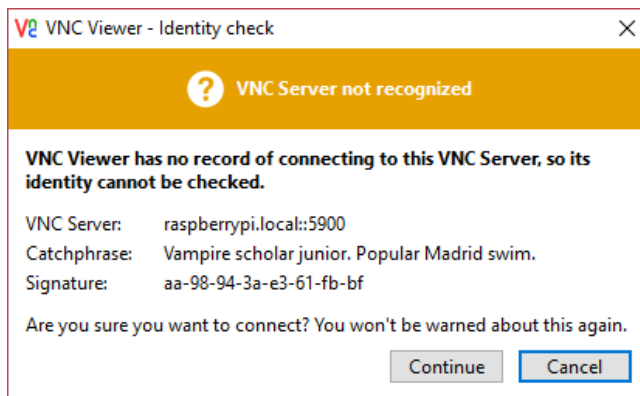
Connecting With VNC

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

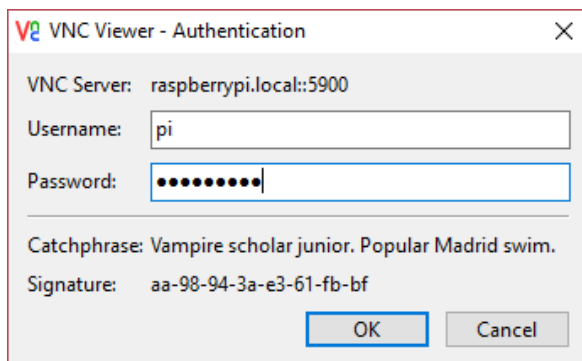


You may need to enter 'raspberrypi' or the IP address of the R-Pi rather than 'raspberrypi.local'

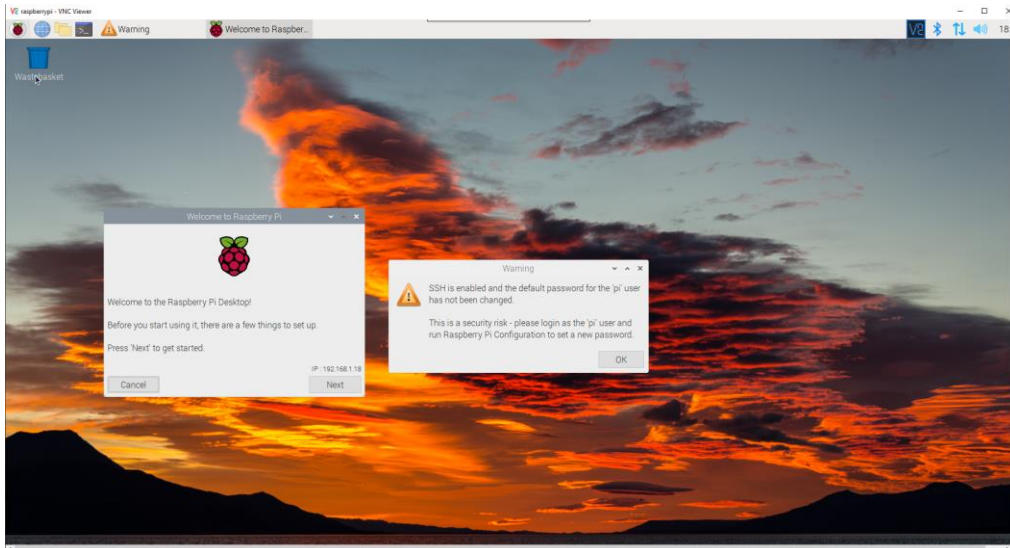
The first time you connect you will see an identity check



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. This may be hidden by the Welcome dialog on first boot.

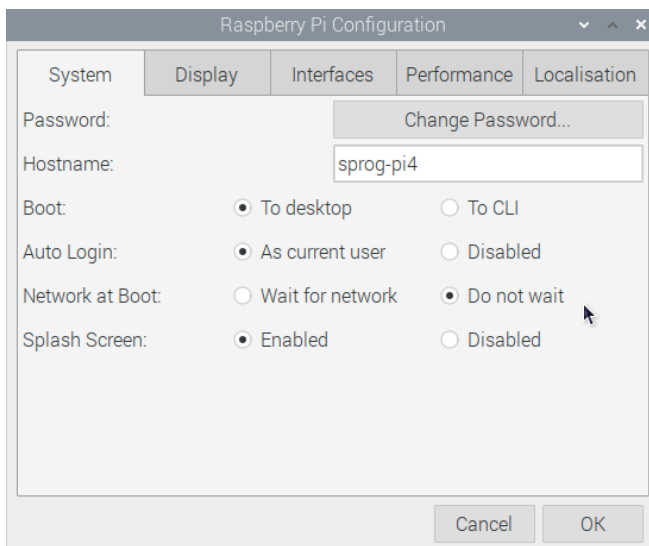


Click OK on the Warning.

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 as we have already done this.

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 Yes to reboot.

Reconnect with VNC using the new hostname and/or password (if you changed them in the previous steps).

Get UART Overlays

We require the UART interfaces to be swapped for the Pi-SPROG 3 so that serial0 is routed to the GPIO connector instead of being used for BlueTooth. We also require RTS and CTS handshaking to be enabled for the Pi-SPROG 3 Plus.

Download the uart-rtstcts overlay. In a terminal window

```
wget https://raw.githubusercontent.com/Hiassoft/AtariSIO/master/contrib/rpi/uart-ctsrts.dtbo
```

Copy it to the required directory.

```
sudo cp uart-ctsrts.dtbo /boot/overlays/
```

(Alternatively download the overlay to your host PC and use the Windows 10 scp utility to copy it to the R-Pi).

Add the overlays to config.txt.

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

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

```
dtoverlay=miniuart-bt
enable_uart=1
dtoverlay=uart-ctsrts
```

Save (Write Out) the file and Exit.

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), or

```
sudo reboot
```

VNC should reconnect when the R-Pi has rebooted. If it doesn't, close the VNC window and connect again.

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

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


The output should be

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

Check that the RTS/CTS handshaking is enabled on the GPIO. In the terminal window, type

```
raspi-gpio get 16
```

The output should show that GPIO 16 is now CTS0:

```
GPIO 16: level=0 fsel=7 alt=3 func=CTS0 pull=DOWN
```

Next, type

```
raspi-gpio get 17
```

The output should show that GPIO 17 is now RTS0:

```
GPIO 17: level=1 fsel=7 alt=3 func=RTS0 pull=DOWN
```

Download and Install Java

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

Open a terminal and type

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

You can check the java version, any time you need to, by typing in a terminal:

```
java --version
```

Install a terminal Emulator for Pi-SPROG 3 Terminal Access

```
sudo apt-get install -y putty
```

Shutdown your R-Pi and remove the power connector.

Connect the Pi-SPROG 3 and its power supply.

Reconnect the R-Pi’s power supply.

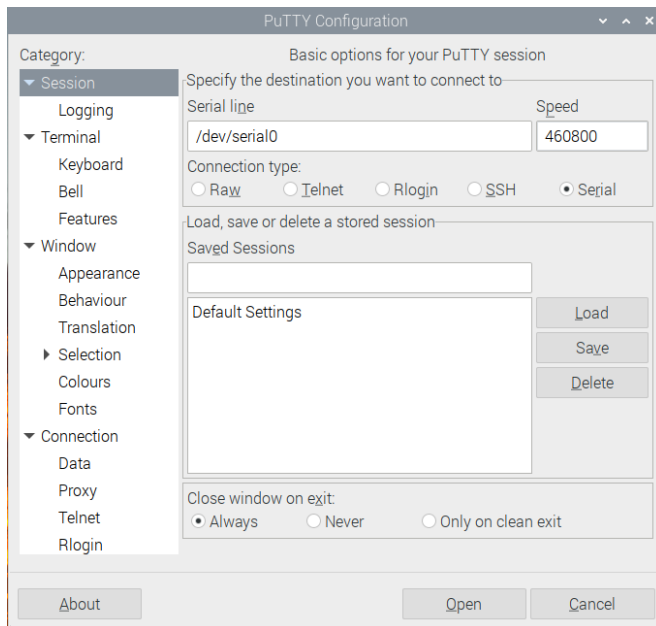
You can test communication with the Pi-SPROG 3 using PuTTY:

```
putty&
```

Setup a serial connection to /dev/serial0.

For Pi-SPROG 3 v2 and Pi-SPROG 3 Plus set the baud rate to 460800.

For Pi-SPROG 3 set the baud rate to 115200.



Open the connection.

As an example, type ? followed by carriage return to see the firmware version.

On a Pi-SPROG 3 v2 or Pi-SPROG 3 Plus you will see something like

```
Pi-SPROG 3 Plus 2b Beta 5 CAN ID = 114 NN = 65534
```

```
Pi-SPROG 3 v2 2b Beta 5 NN = 65534
```

(The Pi-SPROG 3 v2, Pi-SPROG 3 Plus run the same firmware but the Pi-SPROG 3 v2 has no CAN interface).

On a Pi-SPROG 3, you will see something like

```
Pi-SPROG 3 1c Beta 1
```

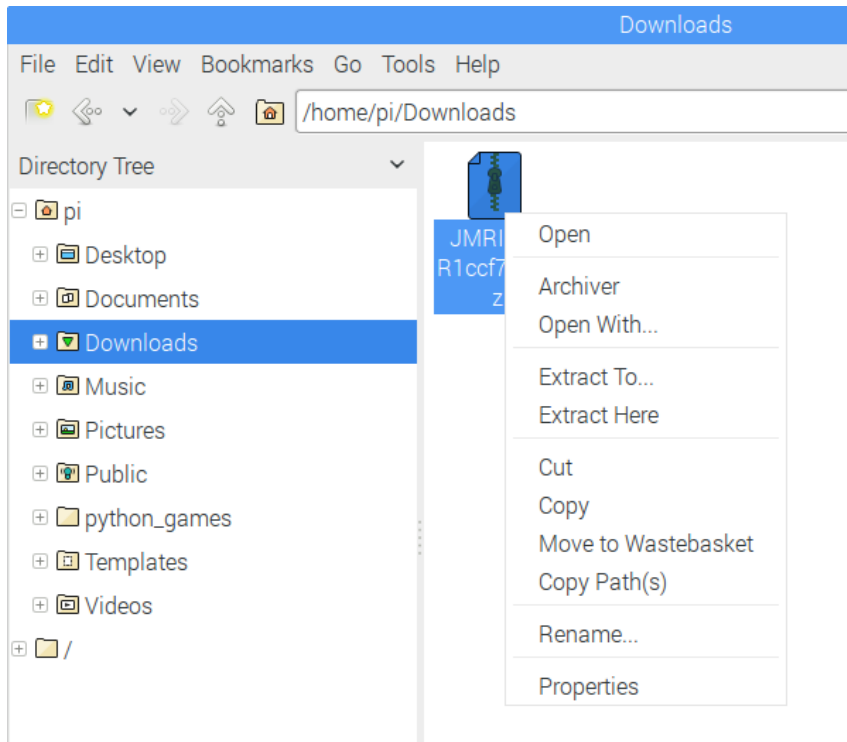
Close the PuTTY window.

You can use PuTTY for diagnostics such as checking that the Pi-SPROG 3 is working and for accessing the SPROG 3 terminal interface for configuration. See the appropriate User Guide for further details.

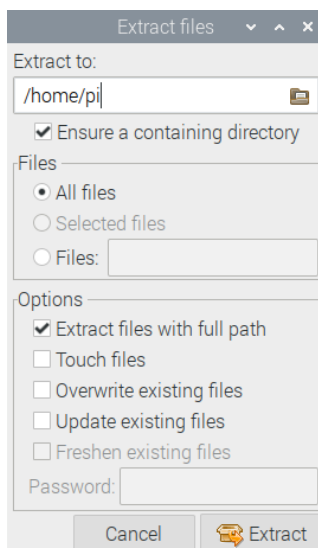
Download and Install JMRI

Using the R-Pi web browser, navigate to www.jmri.org/releases/index.shtml and download your chosen JMRI version for Linux (.tgz file). Download JMRI 4.26, or later, production version to get the latest support for the Pi-SPROG 3. If you need a particular new feature or bug fix you may need to download a later test version.

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 steps.

PanelPro or DecoderPro?

DecoderPro and PanelPro are different interfaces to the same underlying JMRI software. The split exists mainly for historical reasons. There are some differences in the functions that are available from the menus but most features are available through both interfaces.

The Pi-SPROG 3 Plus has two track outputs, one of which supports ‘service mode’ programming on a programming track.

The Pi-SPROG 3 v2 and Pi-SPROG 3 have only a single output that may be switched between service mode programming and layout operation. Unlike earlier SPROG products, it is not necessary to restart DecoderPro or PanelPro, or select a different connection profile, to change the operating mode, so there is no need to create shortcuts for both DecoderPro and PanelPro.

You can use either DecoderPro or PanelPro, depending on your preference.

If you have a Pi-SPROG 3 or Pi-SPROG 3 v2 and will be mainly using it for programming on a programming track then we would recommend DecoderPro as the Roster view is available immediately, rather than requiring a menu selection in PanelPro.

To Create a Desktop Icon for PanelPro

In a terminal window create and edit a desktop shortcut.

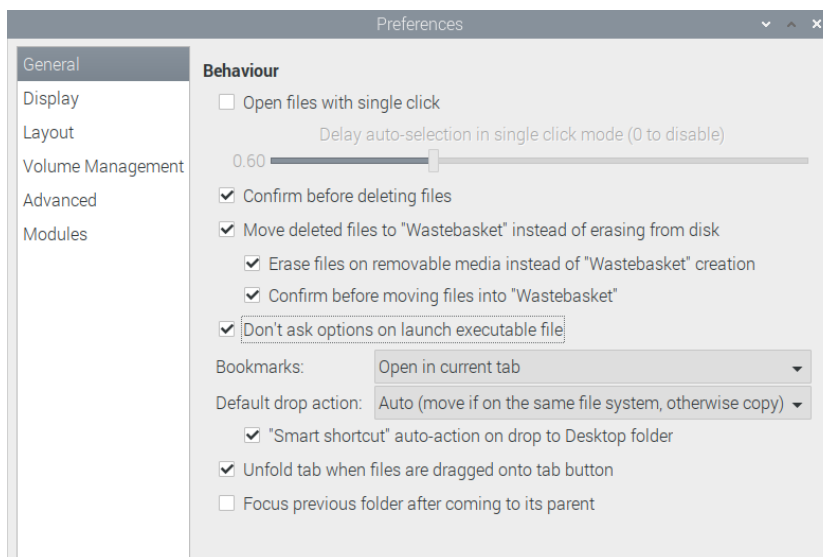
```
sudo nano /home/pi/Desktop/PanelPro
```

```
[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.

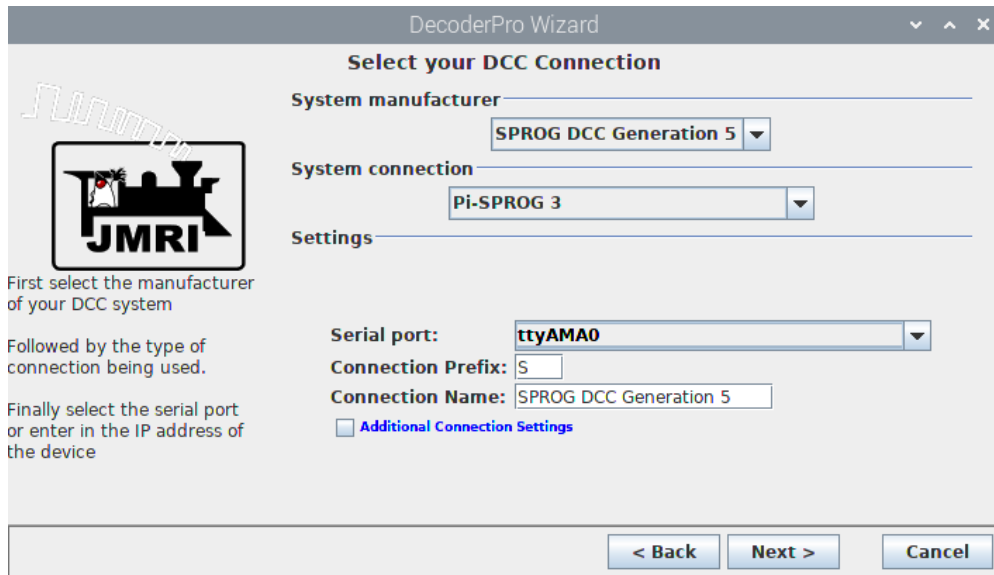
Save the file and quit the editor. A new desktop icon should appear for PanelPro.

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



Start PanelPro by double clicking the desktop icon.

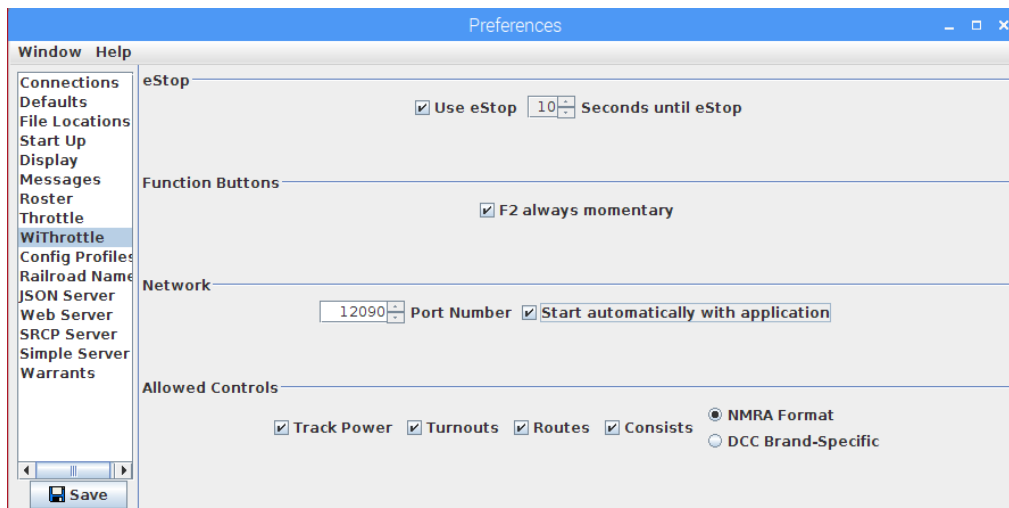
When the Preferences appears (the Chromium web browser may also open), create a new profile by selecting SPROG DCC Generation 5 (**Not** simply SPROG DCC) as the System and Pi-SPROG 3, Pi-SPROG 3 v2 or Pi-SPROG 3 Plus (depending on your SPROG hardware) as the System connection. Select ttyAMA0 as the Serial port.



Keep the Preferences open for the next step.

Start Withrottle Server Automatically (Optional)

If you want to operate your layout using mobile devices as Throttles (cabs) using an Android or iOS app then you can set the WiThrottle server to start automatically. Click WiThrottle in the left hand pane and Select 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.

To Create a Desktop Icon for DecoderPro

In a terminal window create and edit another desktop shortcut.

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

```
[Desktop Entry]
Type=Application
Encoding=UTF-8
Name=DecoderPro
Comment=JMRI DecoderPro
Icon=/home/pi/JMRI/resources/dp3_48x48.gif
Exec=/home/pi/JMRI/DecoderPro
Terminal=false;
```

Save the file and quit the editor. A new desktop icon should appear for DecoderPro.

Start DecoderPro and click New when the Profile selector appears.

Give the Profile a name, e.g., DecoderPro-Pi-SPROG-3v2 (or Plus) and click OK. The name can be any descriptive name you wish to allow distinction between different connection profiles, e.g., if you also have other hardware connected to the Raspberry-Pi.

Click OK.

Click Next.

Work through the connection wizard and set the same preferences as you did for PanelPro. Be sure to select "SPROG DCC Generation 5" and not "SPROG DCC" as the manufacturer.

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 if you do not have a screen and keyboard connected to the Pi.

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.

At this point you may wish to reboot the R-Pi to verify that PanelPro starts up. Then quit PanelPro.

WiFi Access Point (AP) Setup

For reference, these instructions in this section are based on

<https://www.raspberrypi.org/documentation/configuration/wireless/access-point-routed.md>,

without the routing or IP masquerading, 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
    nohook wpa_supplicant
```

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 quit 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
```

```
country_code=GB
interface=wlan0
ssid=sprog-pi4
hw_mode=g
channel=6
macaddr_acl=0
auth_algs=1
ignore_broadcast_ssid=0
wpa=2
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.

Start the services

```
sudo systemctl unmask 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. You may need to adjust your wireless device settings to allow it to connect to a server that does not provide internet access.

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-pi4 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 routing.

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.