Raspberry Pi 3 Model B and JMRI with WiFi Access Point for Pi-SPROG One and Pi-SPROG Nano
2017-04-10-raspian-jessie build

June 2017 © SPROG DCC

These instructions describe the process of setting up a Raspberry Pi 3 Model B as a WiFi access point (AP) for connection by hand-held devices running WiThrottle, EngineDriver or other similar apps.

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.

Hardware Requirements

Raspberry Pi 3 model B and suitable power supply for above

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 Jesse image (2017-04-10 at the time of writing) installed on an SD card. See https://www.raspberrypi.org/documentation/installation/installing-images/README.md

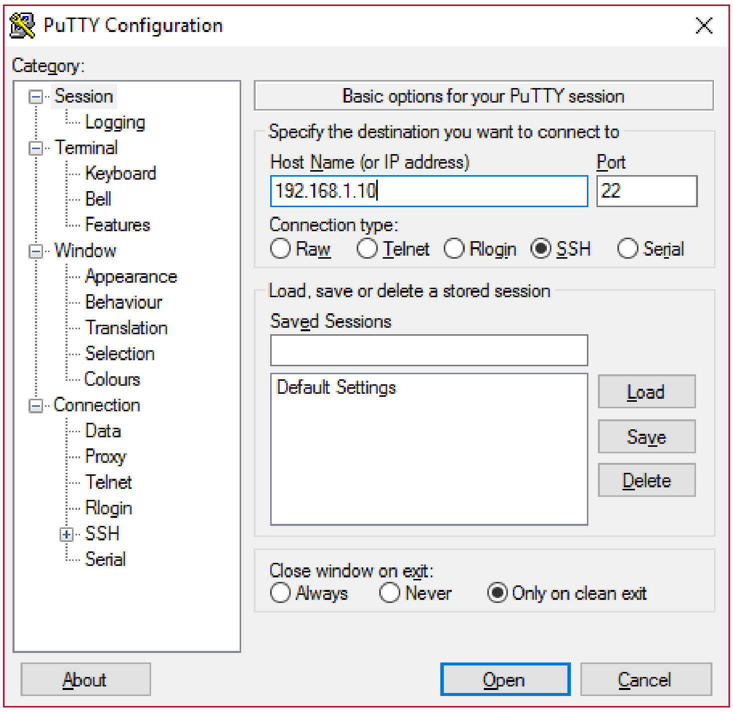
Create a file named ssh in the boot partition to enable SSH. With a windows host do this by viewing the contents of the SD card in Windows Explorer, right click, New Text Document and change the name to ssh. This will enable SSH and allow us to proceed to the next step.

Put the SD card in the R-Pi’s SD card slot and connect power to the R-Pi.

Connecting With SSH

Determine the IP address assigned to the R-Pi by your router. We recommend using your router setup to assign a static IP address to the R-Pi. You will need to refer to your particular router's instructions for this.

Use the IP address in putty to connect to the R-Pi using SSH.



Specify the destination you want to connect to

Host Name (or IP address): 192.168.1.10

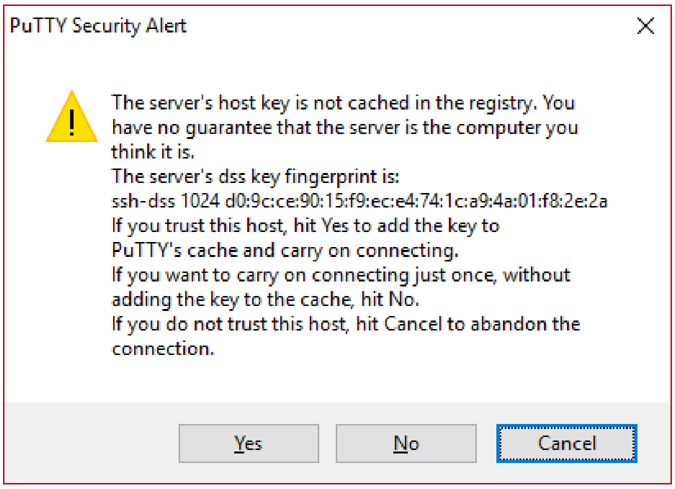
Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

Saved Sessions: Default Settings

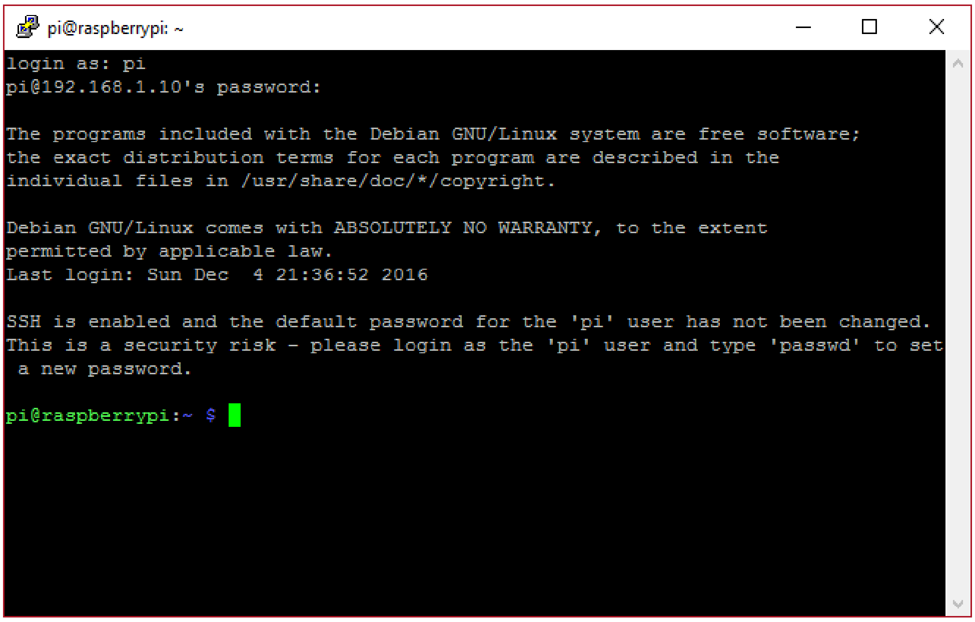
Close window on exit: ○ Always ○ Never ● Only on clean exit

Click Yes if presented with a security alert.



The server's host key is not cached in the registry. You have no guarantee that the server is the computer you think it is.
The server's dss key fingerprint is:
ssh-dss 1024 d0:9c:ce:90:15:f9:ec:e4:74:1c:a9:4a:01:f8:2e:2a
If you trust this host, hit Yes to add the key to PuTTY's cache and carry on connecting.
If you want to carry on connecting just once, without adding the key to the cache, hit No.
If you do not trust this host, hit Cancel to abandon the connection.

When prompted enter the default user name ‘pi’ and password ‘raspberry’



```
login as: pi
pi@192.168.1.10's password:

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: Sun Dec  4 21:36:52 2016

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.

pi@raspberrypi:~ $ 
```

Note the warning message “SSH is enabled …”

We strongly recommend that you change the password before proceeding, especially if you intend making your R-Pi visible on the Internet.

`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.

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 yes if prompted to continue.

Reboot your R-Pi.

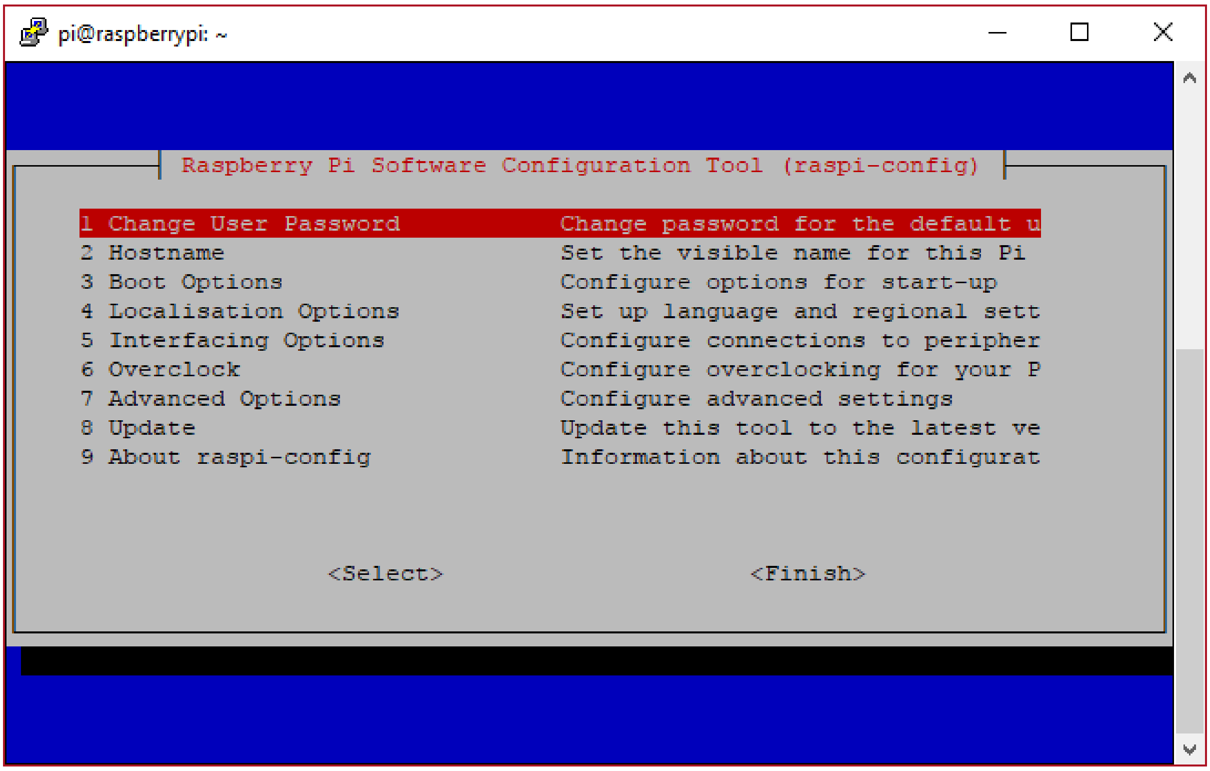
```
sudo reboot
```

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

Enable VNC

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
```



```
Raspberry Pi Software Configuration Tool (raspi-config)

1 Change User Password          Change password for the default u
2 Hostname                      Set the visible name for this Pi
3 Boot Options                  Configure options for start-up
4 Localisation Options          Set up language and regional sett
5 Interfacing Options           Configure connections to peripher
6 Overclock                     Configure overclocking for your P
7 Advanced Options              Configure advanced settings
8 Update                        Update this tool to the latest ve
9 About raspi-config            Information about this configurat

                <Select>                     <Finish>
```

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

Exit raspi-config.

Next we will change the screen resolution for the virtual desktop, see https://support.realvnc.com/knowledgebase/article/View/523?_ga=1.23202815.450528412.1480880479 for the possibilities.

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

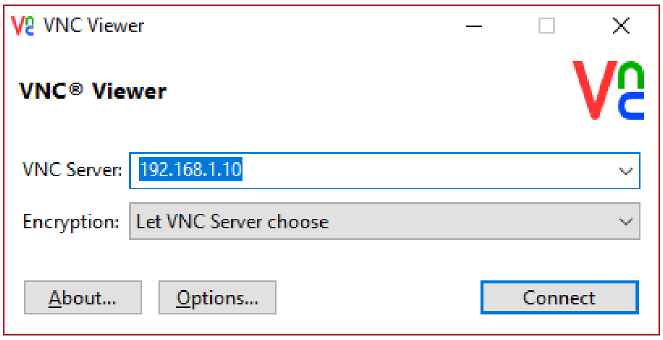
Scroll to the end of the file and add the following lines for 1280x800 resolution. See https://www.raspberrypi.org/documentation/configuration/config-txt.md for other options.

```
hdmi_force_hotplug=1
hdmi_ignore_edid=0xa5000080
hdmi_group=2
hdmi_mode=28
```

Reboot your R-Pi.

Connecting With VNC

Start VNC viewer on the host PC. Enter the IP address and click Connect.



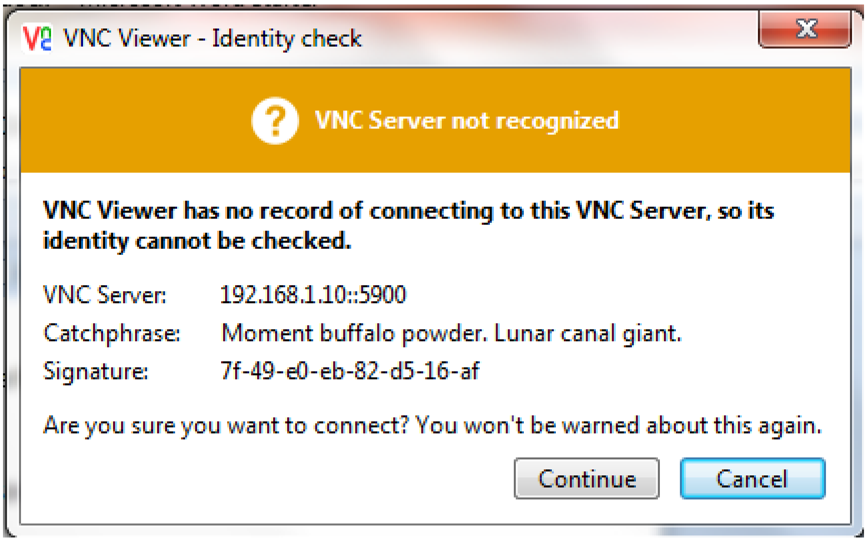
VNC Viewer

VNC® Viewer

VNC Server: 192.168.1.10

Encryption: Let VNC Server choose

The first time you connect you will see an identity check



VNC Viewer - Identity check

VNC Server not recognized

VNC Viewer has no record of connecting to this VNC Server, so its identity cannot be checked.

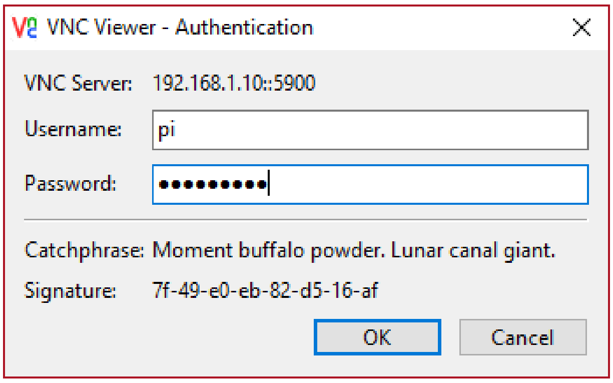
VNC Server: 192.168.1.10::5900

Catchphrase: Moment buffalo powder. Lunar canal giant.

Signature: 7f-49-e0-eb-82-d5-16-af

Are you sure you want to connect? You won't be warned about this again.

Enter the username and password



VNC Viewer - Authentication

VNC Server: 192.168.1.10::5900

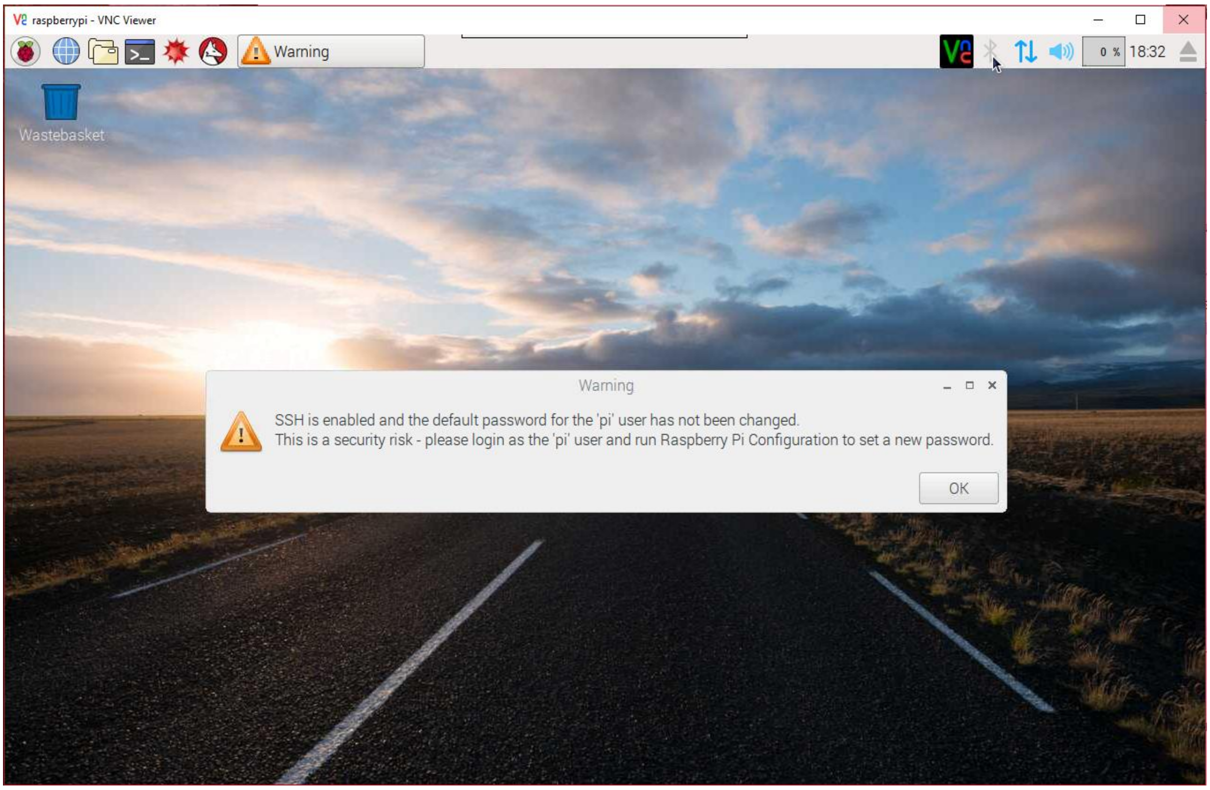
Username: pi

Password: ●●●●●●●●●

Catchphrase: Moment buffalo powder. Lunar canal giant.

Signature: 7f-49-e0-eb-82-d5-16-af

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



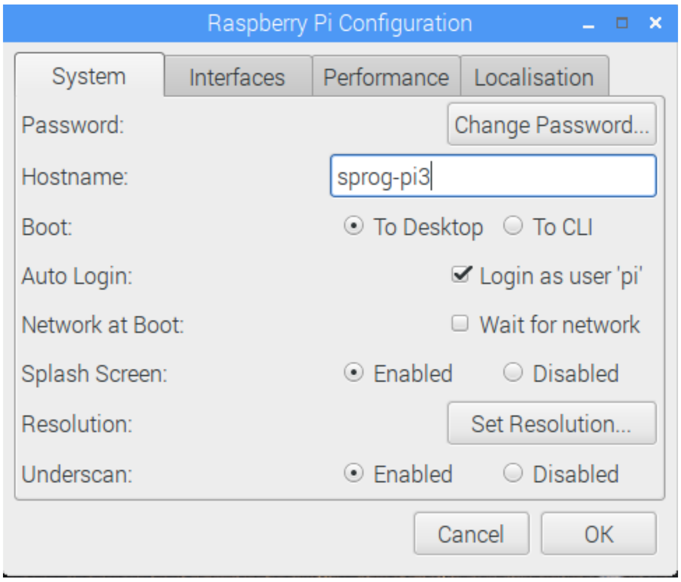
Warning

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 run Raspberry Pi Configuration to set a new password.

OK

R-Pi Configuration

Click the Raspberry logo and select Preferences -> Raspberry Pi Configuration



Password: Change Password...

Hostname: sprog-pi3

Boot: ● To Desktop ○ To CLI

Auto Login: ☑ Login as user 'pi'

Network at Boot: □ Wait for network

Splash Screen: ● Enabled ○ Disabled

Resolution: Set Resolution...

Underscan: ● Enabled ○ Disabled

Cancel OK

Change the Hostname (optional, useful if you have more than one R-Pi). We use sprog-pi3 for our images.

Click OK, then click No to postpone the reboot.

UART setup

We need to swap the UARTs so that serial0 appears on GPIO instead of being used for BlueTooth. This is done by adding an overlay to config.txt. We need to be root to edit this file so open a terminal and type

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

Scroll to the end of the file and add the lines

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

Save the file and quit the editor.

Edit the command line to prevent the Kernel using the UART at startup.

```
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 the file and quit the editor.

Reboot your R-Pi. Close the VNC window.

Reconnect using VNC once the R-Pi has rebooted.

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

Install a terminal Emulator for SPROG Command Line Access

We like to do this for testing purposes, but it is entirely optional.

```
sudo apt-get install minicom
```

Answer yes if prompted to continue.

Shutdown your R-Pi.

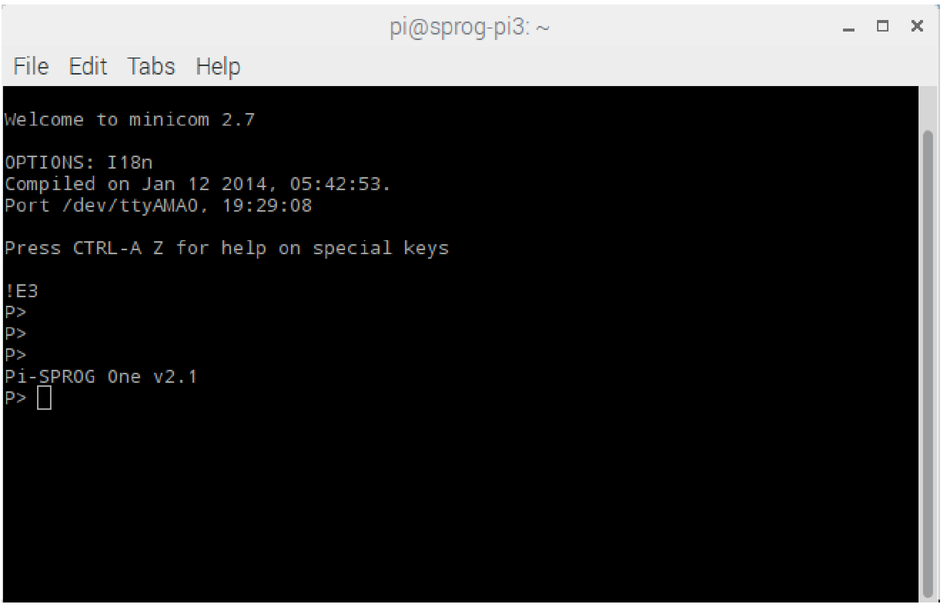
Connect the SPROG-Pi and it’s power supply.

Start your R-Pi.

You can communicate with the Pi-SPROG using Mincom:

```
minicom --device=/dev/serial0 --baud=115200
```

As an example, type carriage return a couple of times to get the SPROG prompt 'P> ' then type a ? followed by carriage return to see the Pi-SPROG version.



```
Welcome to minicom 2.7

OPTIONS: I18n
Compiled on Jan 12 2014, 05:42:53.
Port /dev/ttyAMA0, 19:29:08

Press CTRL-A Z for help on special keys

!E3
P>
P>
P>
Pi-SPROG One v2.1
P> 
```

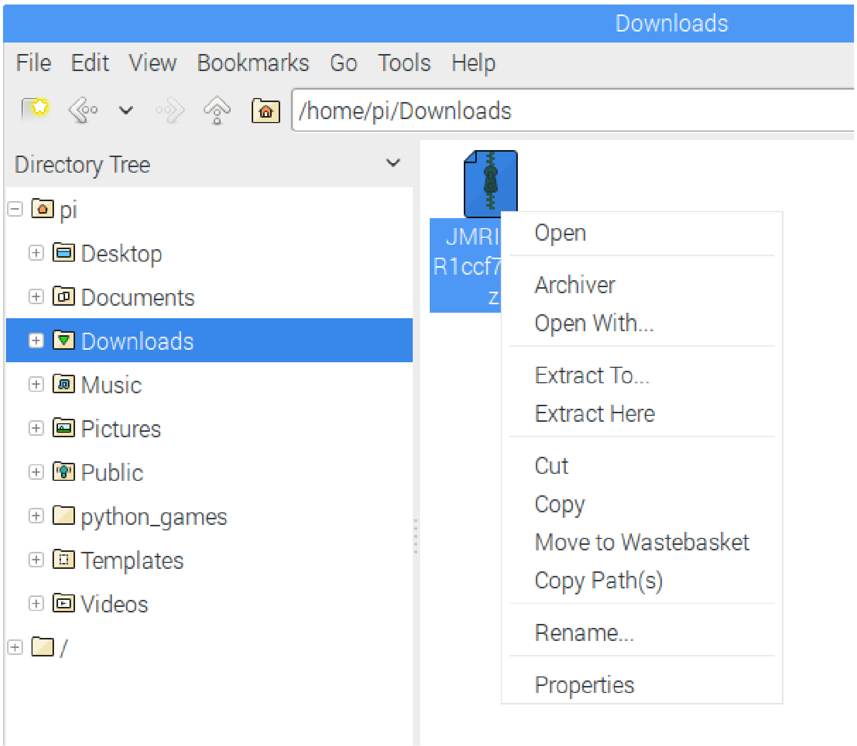
To exit minicom type control-A X then select yes.

You only need to use minicom for diagnostics such as checking that he Pi-SPROG is working. From now on all other communication with the Pi-SPROG will be handled by DecoderPro.

Download and Install JMRI

Using the R-Pi web browser, navigate to www.jmri.org/download/index.shtml and download your chosen JMRI version and extract the archive to /home/pi/ or your preferred location.

Open the Downloads folder in File Manager, right click the downloaded archive and Extract To…



Browse to your chosen location for installing JMRI, creating a new directory if neccessary.

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

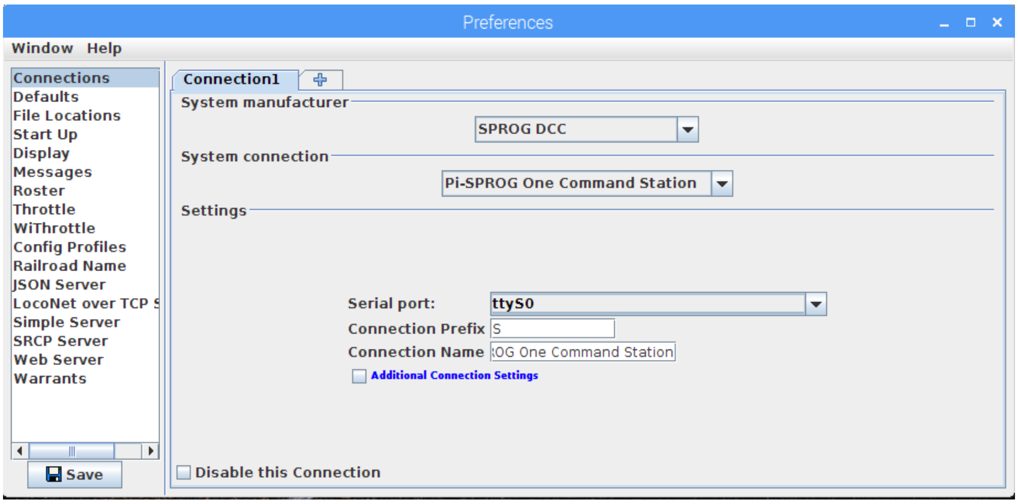
```
sudo nano /home/pi/Desktop/PanelPro.desktop

      [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;
```

Save the file and quit the editor.

Start PanelPro by double clicking the new 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 ttyS0 as the Serial port.



System manufacturer: SPROG DCC

System connection: Pi-SPROG One Command Station

Settings

Serial port: ttyS0

Connection Prefix: S

Connection Name: OG One Command Station

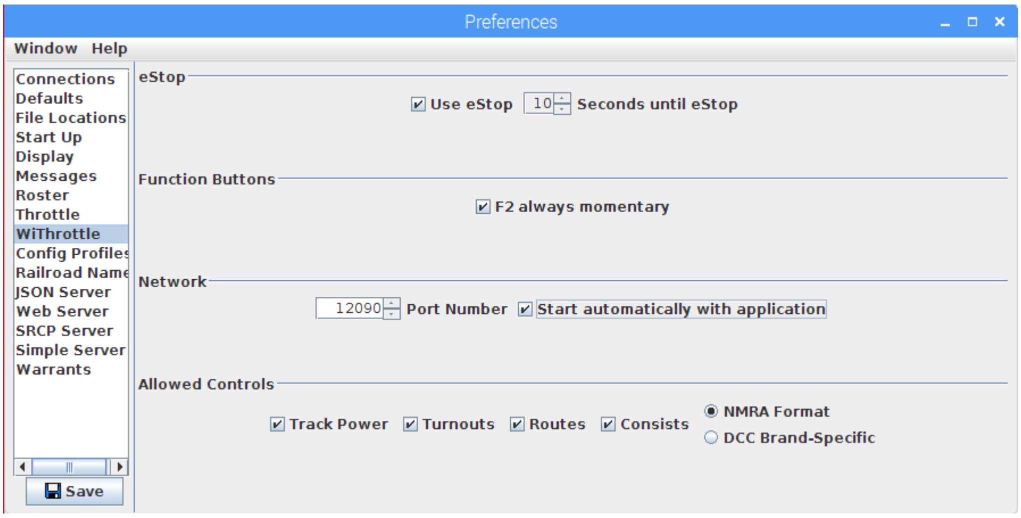
□ Additional Connection Settings

□ Disable this Connection

Keep the Preferences open for the next step.

Start Withrottle Server Automatically

Select WiThrottle, Start automatically with application on port 12090.



eStop

☑ Use eStop 10 Seconds until eStop

Function Buttons

☑ F2 always momentary

Network

12090 Port Number ☑ Start automatically with application

Allowed Controls

☑ Track Power ☑ Turnouts ☑ Routes ☑ Consists ● NMRA Format ○ DCC Brand-Specific

Save the preferences and restart PanelPro. The WiThrottle server should start up.

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.

Run PanelPro (or DecoderPro) at Startup

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.

In a terminal open the session autostart file

```
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://frillip.com/using-your-raspberry-pi-3-as-a-wifi-access-point-with-hostapd/ with our own customization.

Download and install DNS and AP software packages:

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

Answer yes if prompted to continue.

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 dhcpcd managing the WiFi network. Add a line to the end of the configuration file:

```
sudo nano /etc/dhcpcd.conf

      denyinterfaces wlan0
```

Write the file and quit the editor.

Apply the static IP address:

```
sudo nano /etc/network/interfaces
```

Edit the wlan0 section so that it looks like:

```
      allow-hotplug wlan0
      iface wlan0 inet static
      post-up iw dev wlan0 set power_save off
      address 192.168.6.1
      netmask 255.255.255.0
      network 192.168.6.0
      broadcast 192.168.6.255
      #    wpa-conf /etc/wpa_supplicant/wpa_supplicant.conf
```

Write the file and quit the editor.

This will also disable the WiFi power saving which can be too aggressive causing connections to be lost to wireless throttles.

Restart dhcpcd

```
sudo service dhcpcd restart
```

Reload the configuration for wlan0

```
sudo ifdown wlan0; sudo ifup wlan0
```

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.

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

```
      interface=wlan0
      driver=nl80211
      ssid=sprog-pi3
      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
```

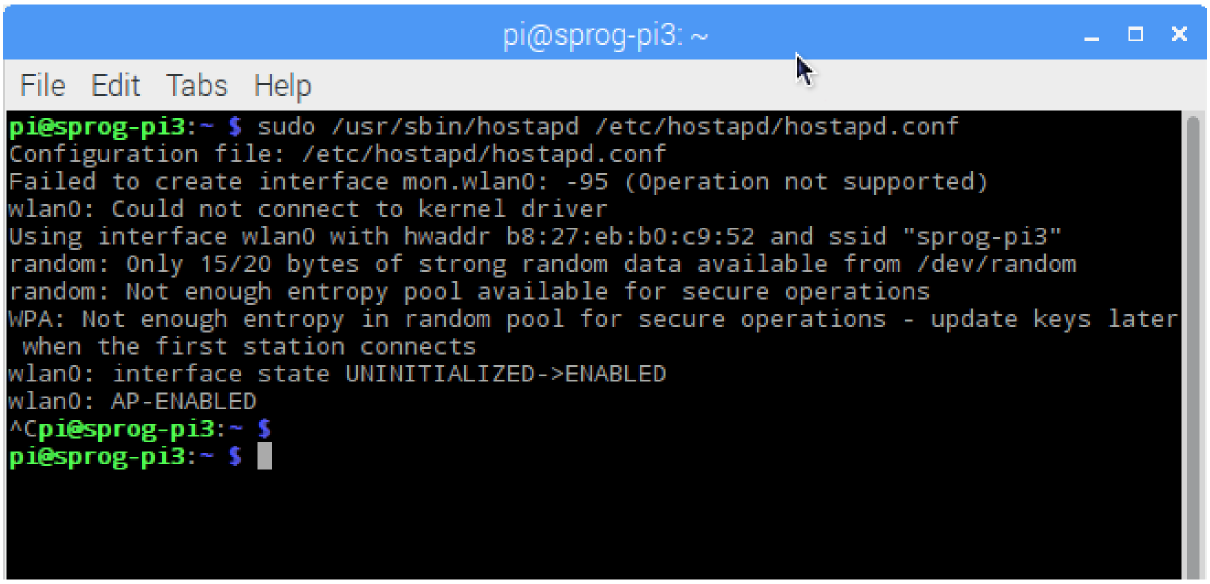
```
wpa=3
wpa_key_mgmt=WPA-PSK
wpa_passphrase=pi-sprog
wpa_pairwise=TKIP
rsn_pairwise=CCMP
eap_reauth_period=360000000
```

Write the file and quit the editor.

Test hostapd

```
sudo /usr/sbin/hostapd /etc/hostapd/hostapd.conf
```

The error relating to mon.wlan0 can be ignored. You should be able to see (but not connect to the new WiFi network “sprog-pi3”, or whatever SSID you used, above.



```
pi@sprog-pi3:~ $ sudo /usr/sbin/hostapd /etc/hostapd/hostapd.conf
Configuration file: /etc/hostapd/hostapd.conf
Failed to create interface mon.wlan0: -95 (Operation not supported)
wlan0: Could not connect to kernel driver
Using interface wlan0 with hwaddr b8:27:eb:b0:c9:52 and ssid "sprog-pi3"
random: Only 15/20 bytes of strong random data available from /dev/random
random: Not enough entropy pool available for secure operations
WPA: Not enough entropy in random pool for secure operations - update keys later
 when the first station connects
wlan0: interface state UNINITIALIZED->ENABLED
wlan0: AP-ENABLED
^Cpi@sprog-pi3:~ $
pi@sprog-pi3:~ $
```

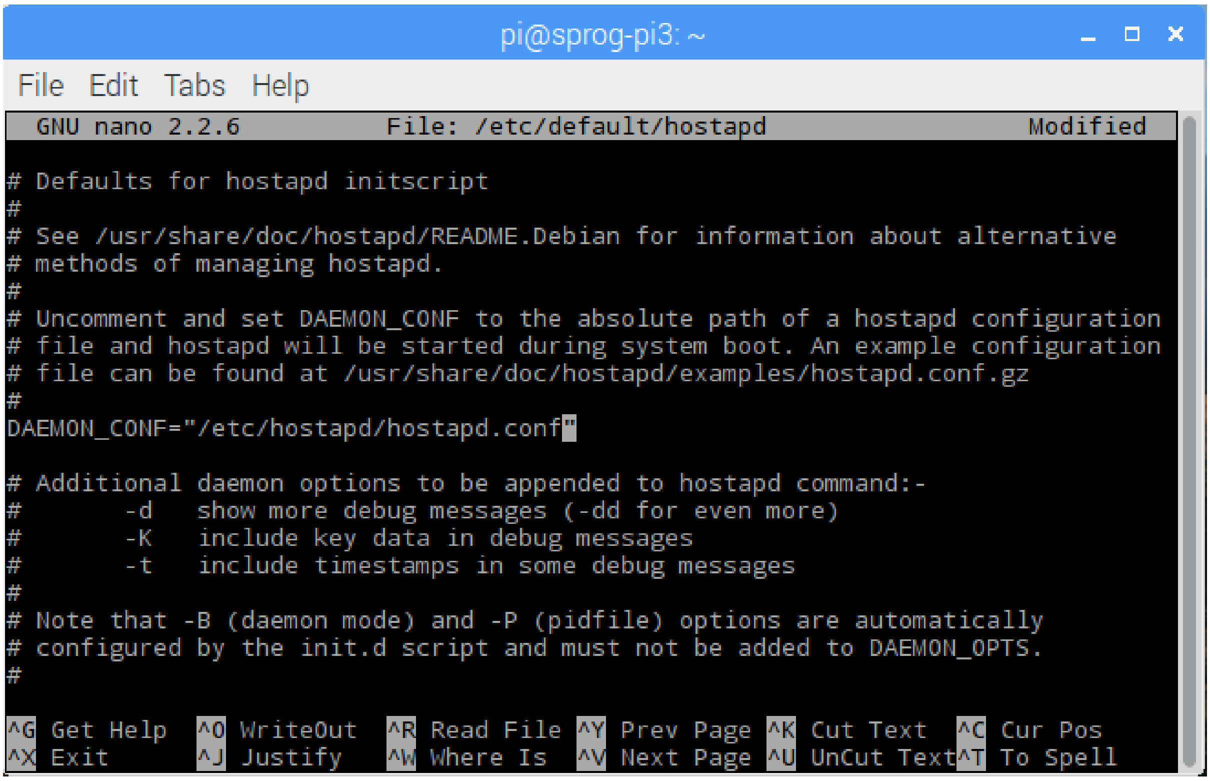
Type Ctrl-C to exit.

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 and enter the path to .conf file you just created.

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



```
  GNU nano 2.2.6           File: /etc/default/hostapd                   Modified

# Defaults for hostapd initscript
#
# See /usr/share/doc/hostapd/README.Debian for information about alternative
# methods of managing hostapd.
#
# Uncomment and set DAEMON_CONF to the absolute path of a hostapd configuration
# file and hostapd will be started during system boot. An example configuration
# file can be found at /usr/share/doc/hostapd/examples/hostapd.conf.gz
#
DAEMON_CONF="/etc/hostapd/hostapd.conf"

# Additional daemon options to be appended to hostapd command:-
#       -d   show more debug messages (-dd for even more)
#       -K   include key data in debug messages
#       -t   include timestamps in some debug messages
#
# Note that -B (daemon mode) and -P (pidfile) options are automatically
# configured by the init.d script and must not be added to DAEMON_OPTS.
#

^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text^T To Spell
```

Save the file and quit the editor.

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.

Start the services

```
sudo service hostapd start
```

```
sudo service dnsmasq start
```

Reboot your R-Pi.

You should now be able to connect to the sprog-pi3 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.

You may also connect to the 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 CNV 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.