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Raspberry Pi 5 for Radio Amateurs

Program and Build Raspberry Pi 5 Based Ham Station Utilities with the RTL-SDR

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Preface

In recent years there have been major changes in the radio equipment used by the radio amateurs. Although the classical HF and mobile equipment is still in use by large numbers of amateurs, computers and digital techniques are becoming very popular among amateur radio operators or 'hams'. In early days of digital communications, personal computers were used by hams to communicate with each other. PCs have the disadvantage that they are rather expensive and bulky. Nowadays, anyone can purchase a £40 Raspberry Pi computer and run almost all of the amateur radio software on this computer, which is slightly bigger than the size of a credit card.

The Raspberry Pi 5 is the latest credit-card sized computer from the Raspberry Pi Foundation that can be used in many applications, such as in audio and video media centers, as a desktop computer, in industrial controllers, robotics, and in many domestic and commercial applications. In addition to many features found in other Raspberry Pi computers, the Raspberry Pi 5 offers Wi-Fi, Classic Bluetooth, and Bluetooth BLE capability which makes it highly desirable in remote and Internet-based control and monitoring applications.

The Raspberry Pi 5 is a 64-bit quad-core Arm Cortex-A76 processor running at 2.4 GHz, which is two to three times the performance boost when compared to the earlier Raspberry Pi 4. The Raspberry Pi 5 comes with an enhanced graphic performance, using the 800-MHz VideoCore VII graphics chip. Additionally, the Raspberry Pi 5 features a Southbridge chipset made for the first time by the Raspberry Pi Foundation. With the help of this RP1 Southbridge, the Raspberry Pi 5 delivers higher performance and functionality for peripheral devices. It should now be possible to carry out many real-time operations such as audio digital signal processing, real-time digital control and monitoring, and many other real-time operations using this tiny powerhouse.

The RTL-SDR devices (V3 and V4 dongles) have become very popular among radio fans because of their very low cost (some around £12) and rich features. A basic system may consist of a USB-based RTL-SDR device (dongle) with a suitable antenna, a Raspberry Pi 5 computer, an USB-based external audio input/output adapter, and software installed on the Raspberry Pi 5 computer. With such a simple setup, it is possible to receive signals from around 24 MHz to over 1.7 GHz.

This book has four purposes. Firstly, it is aimed to teach the installation of the operating system and basic operating principles and features of the Raspberry Pi 5 to beginners. Secondly, many hardware-based projects are given using the Raspberry Pi 5 together with the Python programming language. These projects have been chosen to be useful to amateur radio operators. Thirdly, the book explains in some detail how to use the RTL-SDR devices (both V3 and V4) together with a Raspberry Pi 5 and popular RTL-SDR software to tune in and receive signals from a wide range of ham and other frequency bands. Lastly, the book also explains how to install and use some of the popular amateur radio software packages on the Raspberry Pi 5.

It is important to realize that the book uses the Python programming language on the latest Raspberry Pi 5 platform, and most of the programs in the book will not work on older versions of Raspberry Pi computers. Readers interested in exploring older Raspberry Pi models in amateur radio projects are recommended to purchase author's earlier book entitled: *Raspberry Pi for Radio Amateurs: Program and build RPI-based ham station utilities, tools, and instruments* (available from Elektor).

I hope you enjoy reading the book.

Dogan Ibrahim, G7SCU and Ahmet Ibrahim, 2E1GUC
London, 2024

Chapter 1 • Installing the Raspberry Pi 5 Operating System

1.1 Overview

The Raspberry Pi 5 is the latest credit card size computer from the Raspberry Pi Foundation. It is based on 2.4-GHz Cortex-A76 Arm processor with a new Southgate bridge for handling the peripheral interface. A new VideoCore VII GPU is provided with 800 MHz speed. A dual camera interface is another nice feature of the Raspberry Pi 5. The microSD card interface supports cards that work at much higher speeds than previously.

The Raspberry Pi 5 is similar to the older Raspberry Pi 4, where both devices have dual 2 4Kp60 HDMI display interfaces, although the Pi 5 supports HDR output. The 2×20-pin GPIO interface is the same in both devices. The Raspberry Pi 5 additionally supports two camera interfaces, a PCIe bus connector, a UART interface, an RTC clock power connector, and a fan power connector. Wi-Fi and Bluetooth are supported by both devices. The on-board power switch on the Raspberry Pi 5 is a useful feature. The Raspberry Pi 5 is powered from a 5 V, 4 A USB-C type power supply and is slightly more expensive than the Raspberry Pi 4.

The camera and display connectors on Raspberry Pi 5 are 15-pin and smaller instead of the original 22-pin connector used on Pi 4. A ribbon cable with a 22-pin connector on one side and a 15-pin one on the other side is required to connect an existing Raspberry Pi 4 camera to Raspberry Pi 5. The Raspberry Pi 5 has two connectors, allowing two cameras or DSI displays (or a mix of) to be connected. The PCIe connector is for fast external PCIe compatible peripherals, such as SSDs.

The new power button on Raspberry Pi 5 could be very useful. When the device is ON, pressing the button brings up the shutdown (logout) menu. A safe shutdown will occur with another press of the power button.

Figure 1.1 shows the front view of the Raspberry Pi 5 with the components labelled for reference.

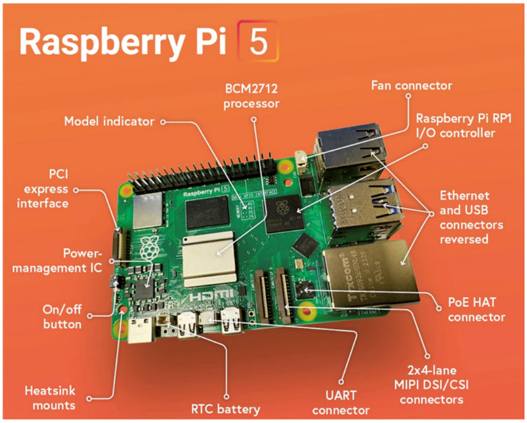


Figure 1.1: The Raspberry Pi 5.

The Raspberry Pi 5 can get very hot when working. While the 'idle' CPU temperature is around 50 degrees Celsius, it can go higher than 85 degrees under stress. It is recommended to use a cooler to lower the CPU temperature. A dedicated active cooler is available for Raspberry Pi 5. Holes and power points are provided on the board to install and power the active cooler. Figure 1.2 shows the Raspberry Pi 5 with the active cooler installed. The active cooler cools down the on-board SoC, RAM, and the Southgate chipset. With the active cooler and when the CPU is idle, the CPU temperature is around 40 degrees. The fan of the cooler operates automatically when the CPU temperature just exceeds 50 degrees Celsius.

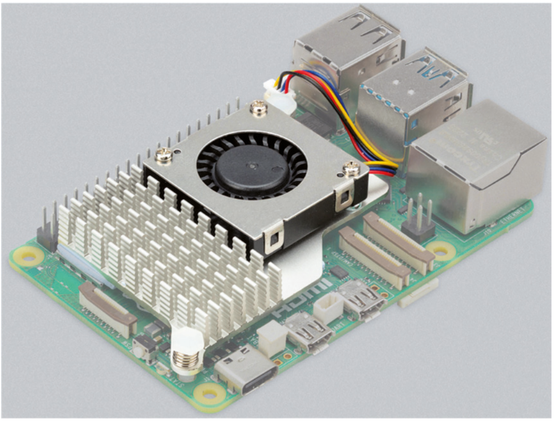


Figure 1.2: Raspberry Pi 5 with active cooler.

The Raspberry Pi 5 operating system called **Bookworm** is available either on a pre-installed micro SD card or by downloading the system image onto a blank micro SD card. In this chapter, you will learn to install the operating system using both methods.

1.2 Using a pre-installed micro SD card

The pre-installed Raspberry Pi 5 operating system is available in various size micro SD cards. The author used the pre-installed 32 GB micro SD card supplied by Elektor. Additionally, the author used a 7-inch HDMI compatible monitor, a Raspberry Pi official keyboard, and a mouse. The author's hardware setup between the Raspberry Pi 5 and various devices is shown in Figure 1.3.

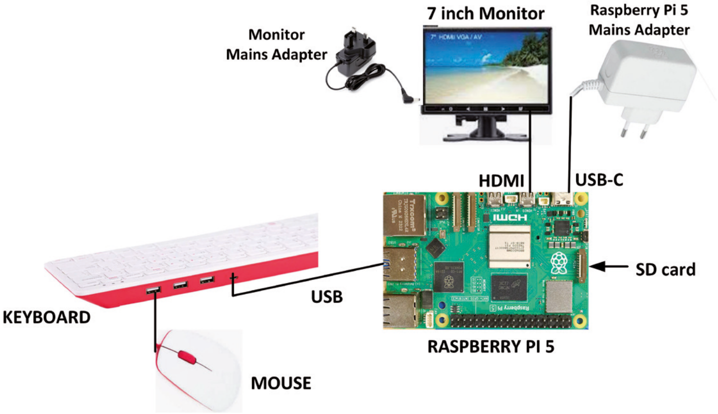


Figure 1.3: The authors' hardware setup.

The steps are as follows:

- Insert the pre-installed micro SD card into your Raspberry Pi 5.
- Connect all the devices as in Figure 1.3.
- Connect the Raspberry Pi 5 adapter to the mains (AC power).
- You should see the Raspberry Pi 5 booting the first time and asking you various questions to setup the device, such as the username, password, WiFi name and password, any updates if necessary, etc. etc. In this book, the username is set to **pi**.
- The Raspberry Pi 5 will boot in Desktop mode and will display the default screen. You can press Cntrl+Alt+F1 at any time to change to the Console mode.

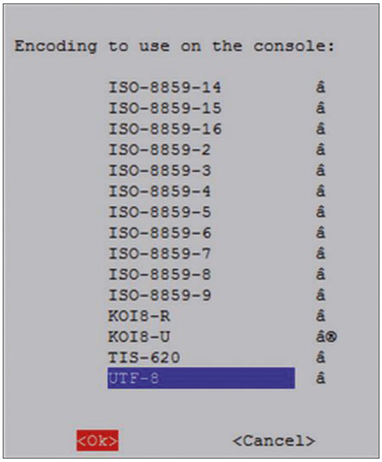
1.3 Larger font in Console mode

It is probably hard to see the characters on a 7-inch monitor in Console mode. You can follow the steps below to increase the font size:

- Make sure you are in the Console mode
- Enter the following command:

```
pi@raspberrypi: ~ $ sudo dpkg-reconfigure console-setup
```

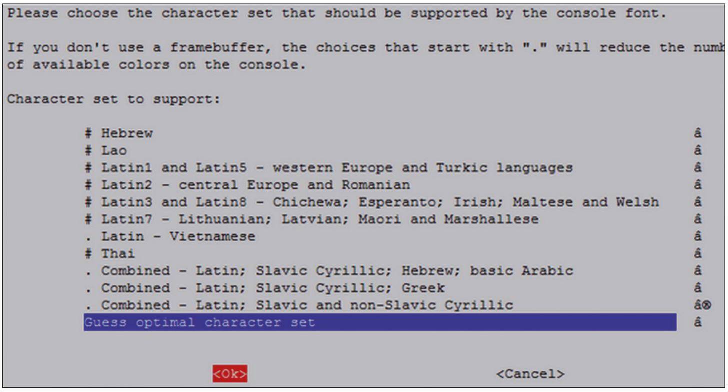
- Select **UTF-8** in the **Package Configuration** screen (Figure 1.4)



```
Encoding to use on the console:

         ISO-8859-14          â
         ISO-8859-15          â
         ISO-8859-16          â
         ISO-8859-2           â
         ISO-8859-3           â
         ISO-8859-4           â
         ISO-8859-5           â
         ISO-8859-6           â
         ISO-8859-7           â
         ISO-8859-8           â
         ISO-8859-9           â
         KOI8-R               â
         KOI8-U               â®
         TIS-620              â
         UTF-8                â


      <Ok>            <Cancel>
```

Figure 1.4: Select UTF-8.

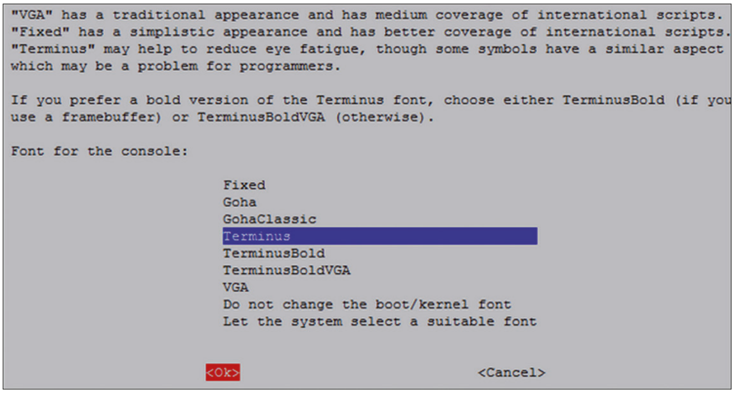
- Select **Guess optimal character set** (Figure 1.5)



```
Please choose the character set that should be supported by the console font.

If you don't use a framebuffer, the choices that start with "." will reduce the numb
of available colors on the console.

Character set to support:

         # Hebrew                                                          â
         # Lao                                                             â
         # Latin1 and Latin5 - western Europe and Turkic languages         â
         # Latin2 - central Europe and Romanian                            â
         # Latin3 and Latin8 - Chichewa; Esperanto; Irish; Maltese and Welsh  â
         # Latin7 - Lithuanian; Latvian; Maori and Marshallese             â
         . Latin - Vietnamese                                              â
         # Thai                                                            â
         . Combined - Latin; Slavic Cyrillic; Hebrew; basic Arabic         â
         . Combined - Latin; Slavic Cyrillic; Greek                        â
         . Combined - Latin; Slavic and non-Slavic Cyrillic                â®
         Guess optimal character set                                       â


                        <Ok>                          <Cancel>
```

Figure 1.5: Select Guess optimal character set.

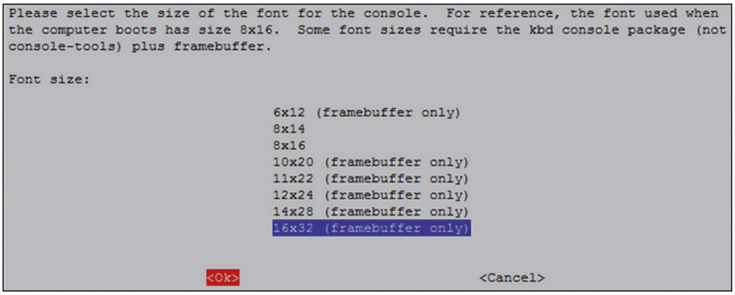
- Select **Terminus** (Figure 1.6)



```
"VGA" has a traditional appearance and has medium coverage of international scripts.
"Fixed" has a simplistic appearance and has better coverage of international scripts.
"Terminus" may help to reduce eye fatigue, though some symbols have a similar aspect
which may be a problem for programmers.

If you prefer a bold version of the Terminus font, choose either TerminusBold (if you
use a framebuffer) or TerminusBoldVGA (otherwise).

Font for the console:

                         Fixed
                         Goha
                         GohaClassic
                         Terminus
                         TerminusBold
                         TerminusBoldVGA
                         VGA
                         Do not change the boot/kernel font
                         Let the system select a suitable font


                        <Ok>                            <Cancel>
```

Figure 1.6: Select Terminus.

- Select font **16x32** (Figure 1.7)



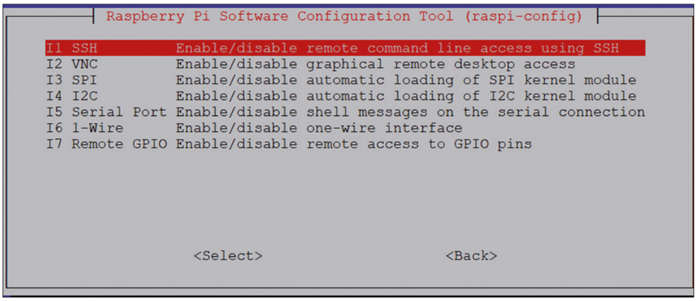
```
Please select the size of the font for the console.  For reference, the font used when
the computer boots has size 8x16.  Some font sizes require the kbd console package (not
console-tools) plus framebuffer.

Font size:

                               6x12  (framebuffer only)
                               8x14
                               8x16
                               10x20  (framebuffer only)
                               11x22  (framebuffer only)
                               12x24  (framebuffer only)
                               14x28  (framebuffer only)
                               16x32  (framebuffer only)


                        <Ok>                            <Cancel>
```

Figure 1.7: Select font 16×32.

1.4 Accessing your Raspberry Pi 5 Console from your PC – the Putty Program

In many applications, you may want to access your Raspberry Pi 5 from your PC. This requires enabling the SSH on your Raspberry Pi and then using a terminal emulation software on your PC. The steps to enable the SSH are as follows:

- Make sure you are in Console mode.
- Type: **sudo raspi-config**.
- Move down to **Interface Options**.
- Highlight **SSH** and press Enter (Figure 1.8).



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

I1 SSH         Enable/disable remote command line access using SSH
I2 VNC         Enable/disable graphical remote desktop access
I3 SPI         Enable/disable automatic loading of SPI kernel module
I4 I2C         Enable/disable automatic loading of I2C kernel module
I5 Serial Port Enable/disable shell messages on the serial connection
I6 1-Wire      Enable/disable one-wire interface
I7 Remote GPIO Enable/disable remote access to GPIO pins




              <Select>                    <Back>
```

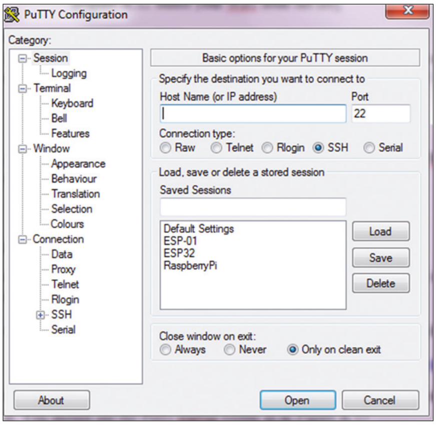
Figure 1.8: Highlight SSH.

- Click **Yes** to enable SSH.
- Click **OK**.
- Move down and click **Finish**.

You will now have to install a terminal emulation software on your PC. The one used by the authors is the popular 'Putty'. Download Putty from the following web site:

https://www.putty.org

- Putty is a standalone program and there is no need to install it. Simply double click to run it. You should see the Putty startup screen as in Figure 1.9.



Specify the destination you want to connect to

Host Name (or IP address): | Port: 22

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

Load, save or delete a stored session

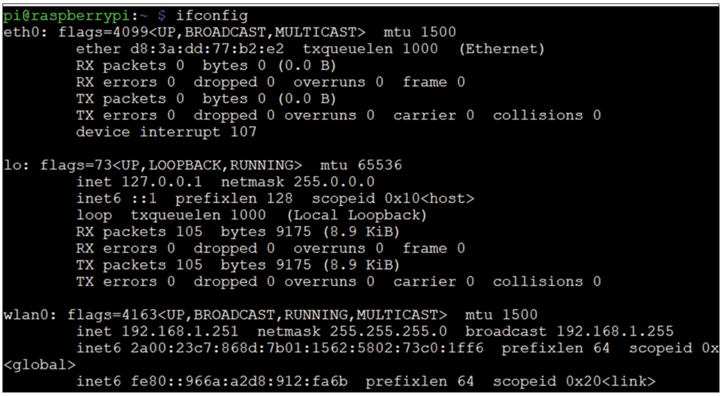
Saved Sessions

Default Settings
ESP-01
ESP32
RaspberryPi

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

Figure 1.9: Putty startup screen.

- Make sure that the Connection type is SSH and enter the IP address of your Raspberry Pi 5. You can obtain the IP address by entering the command **ifconfig** in Console mode (Figure 1.10). In this example, the IP address was: **191.168.1.251** (see under **wlan0:**)



```
pi@raspberrypi:~ $ ifconfig
eth0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether d8:3a:dd:77:b2:e2  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
        device interrupt 107

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 105  bytes 9175 (8.9 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 105  bytes 9175 (8.9 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.251  netmask 255.255.255.0  broadcast 192.168.1.255
        inet6 2a00:23c7:868d:7b01:1562:5802:73c0:1ff6  prefixlen 64  scopeid 0x
<global>
        inet6 fe80::966a:a2d8:912:fa6b  prefixlen 64  scopeid 0x20<link>
```

Figure 1.10: Command ifconfig.

- Click **Open** in Putty after entering the IP address and selecting **SSH**.

- The first time you run Putty you may get a security message. Click **Yes** to accept this security alert.

- You will then be prompted to enter the Raspberry Pi 5 username and password. You can now enter all Console based commands through your PC.

- To change your password, enter the following command:

  pi@raspberrypi: ~ $ **passwd**

- To restart the Raspberry Pi enter the following command:

  pi@raspberrypi: ~ $ **sudo reboot**

- To shut down the Raspberry Pi, enter the following command. By the way, never shut down by pulling the power cable as this may result in the corruption or loss of files!

  pi@raspberrypi: ~ $ **sudo shutdown –h now**

By default, the **Putty** screen background is black with white foreground characters. The authors prefer to have white background with black foreground characters, with the character size set to 12 points bold. You should save your settings so that they are available next time you want to use the Putty. The steps to configure the Putty with these settings are given below:

- Restart Putty.

- Select **SSH** and enter the Raspberry Pi IP address.

- Click **Colours** under **Window**.
- Set the **Default Foreground** and **Default Bold Foreground** colours to black (Red:0, Green:0, Blue:0).
- Set the **Default Background** and **Default Bold Background** to white (Red:255, Green:255, Blue:255).
- Set the **Cursor Text** and **Cursor Colour** to black (Red:0, Green:0, Blue:0).
- Select **Appearance** under **Window** and click **Change** in **Font settings**. Set the font to **Bold 11**.
- Select **Session** and give a name to the session (e.g. MyZero) and click **Save**.
- Click **Open** to open the **Putty** session with the saved configuration.
- Next time you re-start the **Putty**, select the saved session and click **Load** followed by **Open** to start a session with the saved configuration.

1.5 Accessing the Desktop GUI from your PC

If you are using your Raspberry Pi 5 with a local keyboard, mouse, and display you can skip this section. If, on the other hand, you want to access your Desktop remotely over the network, you will find that SSH services cannot be used. The easiest and simplest way to access your Desktop remotely from a computer is by using the VNC (Virtual Network Connection) client and server. The VNC server runs on your Pi and the VNC client runs on your computer. It is recommended to use the **tightvncserver** on your Raspberry Pi 5. The steps are:

- Enter the following command:

```
pi$raspberrypi:~ $ sudo apt-get install tightvncserver
```

- Run the **tightvncserver**:

```
pi$raspberrypi:~ $ tightvncserver
```

You will be prompted to create a password for remotely accessing the Raspberry Pi desktop. You can also set-up an optional read-only password. The password should be entered every time you want to access the Desktop. Enter a password and remember it.

- Start the VNC server after reboot by the following command:

```
pi$raspberrypi:~ $ vncserver :1
```

You can optionally specify screen pixel size and colour depth in bits as follows:

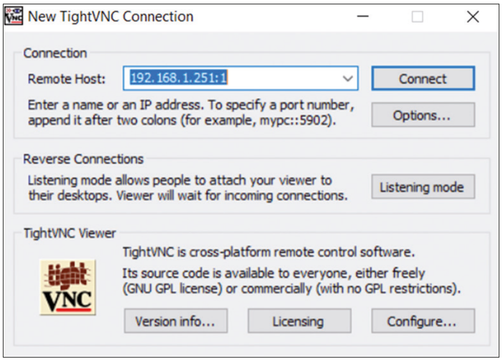
```
pi$raspberrypi:~ $ vncserver :1 –geometry 1920x1080 –depth 24
```

- You should now set up a VNC viewer on our laptop (or desktop) PC. There are many VNC clients available, but the recommended one which is compatible with **TightVNC** is the **TightVNC** for the PC which can be downloaded from the following link:

  https://www.tightvnc.com/download.php

- Download and install the **TightVNC** software for your PC. You will have to choose a password during the installation.

- Start the **TightVNC Viewer** on your PC and enter the Raspberry Pi IP address followed by :1. Click **Connect** to connect to your Raspberry Pi (Figure 1.11)



New TightVNC Connection

Connection

Remote Host: 192.168.1.251:1

Enter a name or an IP address. To specify a port number, append it after two colons (for example, mypc::5902).

Reverse Connections

Listening mode allows people to attach your viewer to their desktops. Viewer will wait for incoming connections.

TightVNC Viewer

TightVNC is cross-platform remote control software.

Its source code is available to everyone, either freely (GNU GPL license) or commercially (with no GPL restrictions).

Figure 1.11: Connect to TightVNC Viewer.

- Enter the password you have chosen earlier. You should now see the Raspberry Pi 5 Desktop displayed on your PC screen (Figure 1.12)

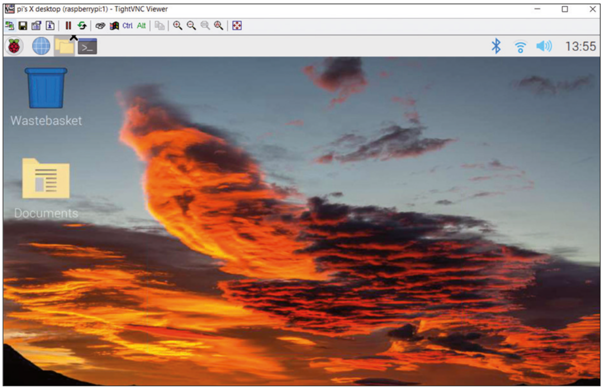


Figure 1.12: Raspberry Pi 5 Desktop.

- The VNC server is now running on your Raspberry Pi 5 and you have access to the Desktop GUI.

1.6 Assigning a Static IP Address to your Raspberry Pi 5

When you try to access your Raspberry Pi 5 remotely over your local network, it is possible that the IP address given by your Wi-Fi router changes from time to time. This is annoying as you have to find out the new IP address allocated to your Raspberry Pi. Without knowing the IP address, you cannot log in using the SSH or the VNC.

In this section, you will learn how to fix your IP address so that it does not change between reboots. The steps are as follows:

- Log in to your Raspberry Pi 5 via Putty.

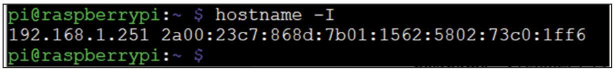
- Check whether DHCP is active on your Raspberry Pi (it should normally be active):

```
pi@raspberrypi:~ $ sudo service dhcpcd status
```

If DHCP is not active, activate it by entering the following commands:

```
pi@raspberrypi:~ $  sudo service dhcpcd start
pi@raspberrypi:~ $  sudo systemctl enable dhcpcd
```

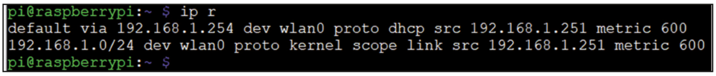
- Find the IP address currently allocated to you by entering command **ifconfig** or **hostname – I** (Figure 1.13). In this example the IP address was: 191.168.1.251. You can use this IP address as your fixed address since no other device on the network is currently using it.



```
pi@raspberrypi:~ $ hostname -I
192.168.1.251 2a00:23c7:868d:7b01:1562:5802:73c0:1ff6
pi@raspberrypi:~ $
```

Figure 1.13: Find the IP address using command hostname -I.

- Find the IP address of your router by entering the command **ip r** (Figure 1.14). In this example, the IP address was: 191.168.1.254.

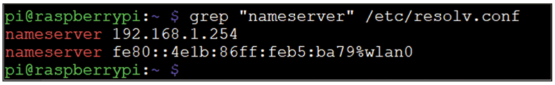


```
pi@raspberrypi:~ $ ip r
default via 192.168.1.254 dev wlan0 proto dhcp src 192.168.1.251 metric 600
192.168.1.0/24 dev wlan0 proto kernel scope link src 192.168.1.251 metric 600
pi@raspberrypi:~ $
```

Figure 1.14: Find the IP address of your router.

- Find the IP address of your DNS by entering the following command (Figure 1.15). This is usually same as your router address:

```
pi@raspberrypi:~ $  grep "nameserver" /etc/resolv.conf
```



```
pi@raspberrypi:~ $ grep "nameserver" /etc/resolv.conf
nameserver 192.168.1.254
nameserver fe80::4e1b:86ff:feb5:ba79%wlan0
pi@raspberrypi:~ $
```

Figure 1.15: Find the DNS address.

- Edit file **/etc/dhcpcd.conf** by entering the command:

  pi@raspberrypi:~ $ **nano /etc/dhcpcd.conf**

- Add the following lines to the bottom of the file (these will be different for your router). If these lines already exist, remove the comment character **#** at the beginning of the lines and change the lines as follows (you may notice that **eth0** for Ethernet is listed):

  ```
  interface wlan0
  static_routers=191.168.1.254
  static domain_name_servers=191.168.1.254
  static ip_address=191.168.1.251/24
  ```

- Save the file by entering **CNTRL + X** followed by **Y** and reboot your Raspberry Pi.

- In this example, the Raspberry Pi should reboot with the static IP address: 191.168.1.251.

1.7 Enabling Bluetooth

In this section, you will see how to enable the Bluetooth on your Raspberry Pi 5 so that it can communicate with other Bluetooth devices. The steps are given below:

- Enable the Bluetooth on your other device.

- Click on the Bluetooth icon on your Raspberry Pi 5 at the top right hand side and select **Make Discoverable.** You should see the Bluetooth icon flashing.

- Select raspberrypi in the Bluetooth menu on your other device.

- Accept the pairing request on your Raspberry Pi 5.

- You should now see the message **Connected Successfully** on your Raspberry Pi 5. and you can exchange files between your other device and the Raspberry Pi computer.

1.8 Connecting the Raspberry Pi 5 to a Wired Network

You may want to connect your Raspberry Pi 5 to a network through an Ethernet cable. The steps are as follows:

Step 1: Connect a network cable between your Raspberry Pi 5 and your WiFi router.

Step 2: Connect keyboard, mouse and monitor to your Raspberry Pi and power up as normal.

Step 3: Log in to the system by entering your username and password.

Step 4: Providing your network hub supports DHCP (nearly all network routers support DHCP), you will be connected automatically to the network and will be assigned a unique IP address within your network. Note that DHCP assigns IP addresses to newly connected devices.

Step 5: Check to find out the IP address assigned to your Raspberry Pi 5 by the network router. Enter command **ifconfig** as described earlier.

1.8.1 Unable to connect to a wired network

If you find that you are not assigned an IP address by the DHCP, the possible causes are:

- your network cable is faulty;
- the network hub does not support DHCP;
- your Raspberry Pi is not enabled to accept DHCP issued addresses. i.e. it may have been configured for fixed IP addresses.

In most cases it is very unlikely that the network cable is faulty. Also, most network hubs support the DHCP protocol. If you are having problems with the network, it is possible that your Raspberry Pi is not configured to accept DHCP issued addresses. The Raspberry Pi is normally configured to accept DHCP addresses but it is possible that you have changed the configuration somehow.

To resolve the wired network connectivity problem, follow the steps given below.

Step 1: find out whether or not your Raspberry Pi is configured for DHCP or fixed IP addresses. Enter the following command:

```
pi@raspberrypi ~$ cat /etc/network/interfaces
```

If your Raspberry Pi is configured to use the DHCP protocol (which is normally the default configuration), the word **dhcp** should appear at the end of the following line:

```
iface eth0 inet dhcp
```

If on the other hand your Raspberry Pi is configured to use static addresses then you should see the word **static** at the end of the following line:

```
iface eth0 inet static
```

Step 2: To use the DHCP protocol, edit file **interfaces** (e.g. using the **nano** text editor) and change the word **static** to **dhcp**. It is recommended to make a backup copy of the file interfaces before you change it:

```
pi@raspberrypi ~$ sudo cp /etc/network/interfaces /etc/network/int.bac
```

You should now restart your Raspberry Pi and an IP address will probably be assigned to your device.

Step 3: To use static addressing, make sure that the word **static** appears as shown above. If not, edit file **interfaces** and change **dhcp** to **static**

Step 4: You need to edit and add the required unique IP address, subnet mask and gateway addresses to file **interfaces** as in the following example (this example assumes that the required fixed IP address is 191.168.1.251, the subnet mask used in the network is 255.255.255.0, and the gateway address is 191.168.1.1):

```
iface eth0 inet static
address 191.168.1.251
netmask 255.255.255.0
gateway 191.168.1.1
```

Save the changes and exit the editor. If you are using the **nano** editor, exit by pressing Ctrl+X, and then enter Y to save the changes, and enter the filename to write to as **/etc/network/interfaces**.

Re-start your Raspberry Pi 5.

1.9 Installing the Raspberry Pi 5 Bookworm Operating System on a Blank microSD Card

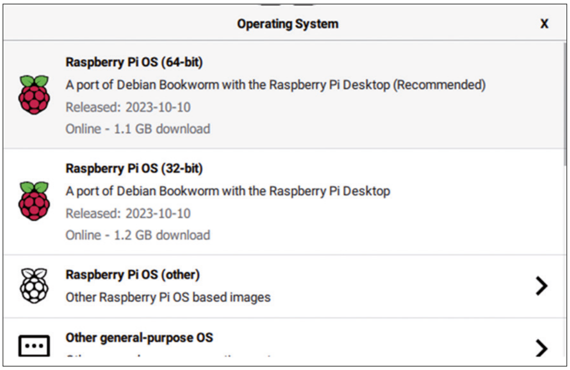
If you have a pre-installed 'Bookworm' Raspberry Pi operating system on a microSD card then you can start using it as described earlier in this chapter. In this section, you will learn how to install the latest Bookworm operating system on a microSD card if you do not have a pre-installed card.

The steps are as follows:

- Insert a microSD card into your PC. You may need to use an SD card adapter.
- Go to the website: https://www.raspberrypi.com/software/
- Click to download the **Raspberry Pi Imager.** At the time of writing this book this file was called: **imager_1.7.5.exe**.
- Double click to start the imager program and click to install it.

- Click to **Finish** to run the imager.

- Click **Operating System** and select the operating system at the top of the list as: **Raspberry Pi OS (64-bit)**. See Figure 1.16.



Operating System X

Raspberry Pi OS (64-bit)
A port of Debian Bookworm with the Raspberry Pi Desktop (Recommended)
Released: 2023-10-10
Online - 1.1 GB download

Raspberry Pi OS (32-bit)
A port of Debian Bookworm with the Raspberry Pi Desktop
Released: 2023-10-10
Online - 1.2 GB download

Raspberry Pi OS (other)
Other Raspberry Pi OS based images

Other general-purpose OS

Figure 1.16: Select the operating system.

- Click **Storage** and select the SD card storage.

- Click to open the settings (gear shape).

- Click to enable SSH.

- Click to enable password authentication.

- Set username and password.

- Click to **Configure wireless LAN**.

- Click **Save**.

- Click **Write** to write the operating system to the microSD card.

- Wait until writing and verifying are finished (Figure 1.17).

- Remove the microSD card and insert into your Raspberry Pi 5.

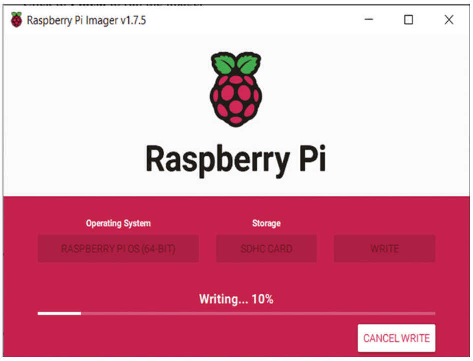


Figure 1.17: Writing to the micro SD card.

If you have a monitor and keyboard, you can log in to your raspberry Pi 5 directly and start using it. Otherwise, find the IP address of your Raspberry Pi 5 (e.g., from your router, or there are many apps for smartphones, such as **who's on my wifi**, showing all the devices connected to your router with their IP addresses). Then log in to your Raspberry Pi 5 and start using it.

Chapter 2 • Using a Text editor, Creating and Running a Python Program

A text editor is used to create or modify the contents of a text file. There are many text editors available for the Linux operating system. Some popular ones are nano, vim, vi, and many more. In this Chapter, you will be learning how to use the popular text editor called **nano**. Additionally, you will be learning the different methods of creating and running a Python program.

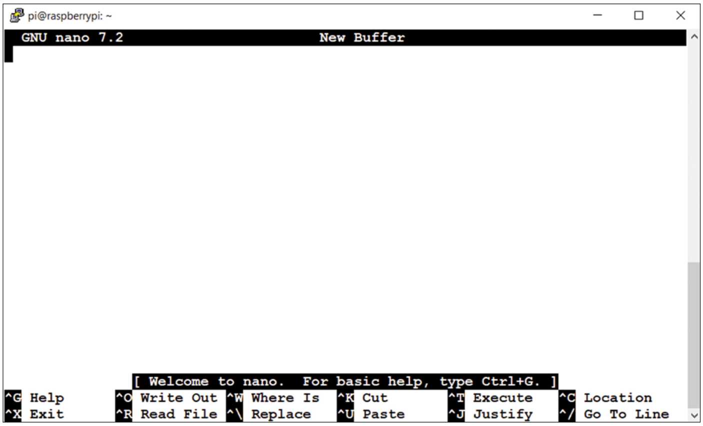
2.1 The nano Text Editor

This is probably the most commonly used text editor. Start the **nano** text editor by entering the word **nano**, followed by the filename you wish to create or modify. An example is given below, where a new file called **first.txt** is created:

```
pi@raspberrypi: ~ $ nano first.txt
```

You should see the editor screen as in Figure 2.1. The name of the file to be created or modified is displayed at the top middle part of the screen. The message **New File** at the bottom of the screen shows that this is a newly created file. The shortcuts at the bottom of the screen are there to perform various editing functions. These shortcuts are accessed by pressing the Ctrl key together with another key. Some of the useful shortcuts are described below:

Ctrl+W: Search for a word.
Ctrl+V: Move to next page.
Ctrl+Y: Move to previous page.
Ctrl+K: Cut the current row of txt.
Ctrl+R: Read file.
Ctrl+U: Paste the text you previously cut.
Ctrl+J: Justify.
Ctrl+\: Search and replace text.
Ctrl+C: Display current column and row position.
Ctrl+G: Get detailed help on using nano.
Ctrl+-: Go to specified line and column position.
Ctrl+O: Save (write out) the file currently open.
Ctrl+X: Exit nano.

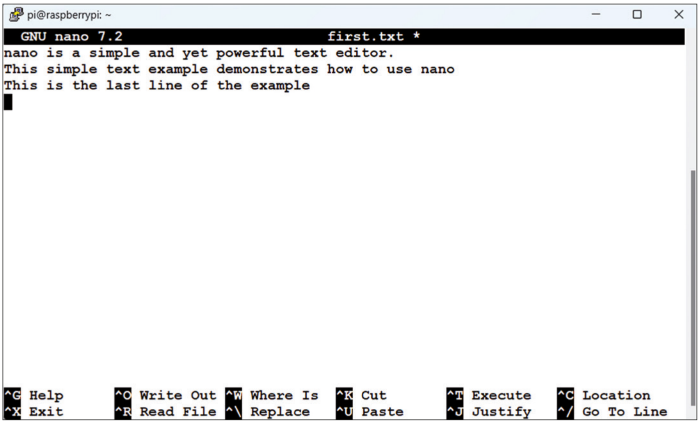


```
pi@raspberrypi: ~
  GNU nano 7.2                      New Buffer

                  [ Welcome to nano.  For basic help, type Ctrl+G. ]
^G Help         ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location
^X Exit         ^R Read File  ^\ Replace    ^U Paste      ^J Justify    ^/ Go To Line
```

Figure 2.1: nano text editor screen.

Now, type the following text as shown in Figure 2.2:

```
nano is a simple and yet powerful text editor.
This simple text example demonstrates how to use nano.
This is the last line of the example.
```



```
pi@raspberrypi: ~
  GNU nano 7.2                       first.txt *
nano is a simple and yet powerful text editor.
This simple text example demonstrates how to use nano
This is the last line of the example

^G Help         ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location
^X Exit         ^R Read File  ^\ Replace    ^U Paste      ^J Justify    ^/ Go To Line
```

Figure 2.2: Sample text.

The use of **nano** is now demonstrated with the following steps.

Step 1: Go the beginning of the file by moving the cursor up and left.

Step 2: Look for word **simple** by pressing **Ctrl+W** and then typing **simple** in the window opened at the bottom left hand corner of the screen. Press the Enter key. The cursor will be positioned on the word **simple** (see Figure 2.3).