# Getting Started with Raspberry Pi

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# Contents

# 1 Introduction

## 1.1 What is a Raspberry Pi?

The Raspberry Pi is an tiny computer, that includes a microprocessor, a bit of memory, a slot for an SD card, input/output (I/O) ports, e.g. HDMI, USB, headphone, camera, and some general purpose input/output (GPIO) pins for various types of electrical connectors.

## 1.2 Why use the Raspberry Pi?

Generally, Raspberry Pis draw considerably less power than regular computers, are a lot smaller, and are relatively cost-effective. In addition, the GPIO pins allow for connecting and controlling various types of electrical components, such as LEDs and sensors. Raspberry Pis are very flexible devices. They can be used for personal computers, home survaillance systems, weather stations, adblockers for your home network, retro gaming machines, as an AI assistant, and so much more! In this class, we'll be using it as an environmental monitoring device.

# 2 Unpacking and Connecting the Pi

## 2.1 Packaging List

### 2.1.1 "Vilros RP Zero W Basics Kit"

1. Raspberry Pi Zero W board
2. Case, with 3 covers
3. 2.5A power supply
4. Heatsink
5. HDMI to mini-HDMI adapter
6. USB to micro-USB adapter
7. Header pin diagram
8. Camera module adapter (not used)

### 2.1.2 Other items

1. SD card
2. SD card to USB adapter
3. USB multiport adapter
4. Breadboard

5. Wires
6. Line level converter (LLC)
7. MCP3008
8. MQ-135
9. MQ-XXX
10. MQ-XXX

## 2.2 Install Raspberry Pi OS on SD card

1. Download Raspberry Pi Imager for your main computer's operating system (OS) at `https://www.raspberrypi.org/downloads/`
2. Install Raspberry Pi Imager
3. Connect the Pi's SD card to your main computer.
4. Use Raspberry Pi Imager to install/write Raspberry Pi OS to SD card.
5. Alternatively, manually copy Raspberry Pi OS and NOOBS to SD card, using the link above.

## 2.3 Add network configuration file to SD card for a secure shell (SSH) connection.

1. Add a "ssh" file to your boot partition on the SD card.
   - Do this by creating a text file named **"ssh"**.
   - Make sure the file you create has no file extension.
2. Create and add a file called **"wpa_supplicant.conf"** to the boot partition on the SD card. This can be created with any text editor.
   - Make sure the file you created has the **".conf"** file extension in the name.
   - The **"wpa_supplicant.conf"** needs to have the WiFi network information in it for the Raspberry Pi to connect on boot up.
   - Modify this file with a text editor and include the following information:

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
country=US

network={
 ssid="WIFI NETWORK NAME"
 psk="WIFI PASSWORD"
}
```

- If you are not in the United States, input your country's ISO code instead of **"US"** on the ***"country=US"*** line.
- Make sure to change **"WIFI NETWORK NAME"** to your WiFi network name.
- Make sure to change **"WIFI_PASSWORD"** to your WiFi network's password.

## 2.4 Assemble and Connecting the Pi

### 2.4.1 Putting the Pi together

1. Safely eject the SD card from your main computer.
2. Place the SD card in the Raspberry Pi Zero W's SD card slot.
3. Attach the Pi to the bottom Vilros case making sure to line the dowels within the case with the mouting holes on the Pi.
4. **Do not** attached the top part of the case yet. Being able to see the Pi's board will help you with pin determination.
5. Attach your peripheral devices, *if you have them.* This includes a monitor, mouse, and keyboard. It is okay to not have them.
   - You will need to use the HDMI to micro-HDMI adapter to hook a monitor up to the Raspberry Pi Zero W.
   - Also, you'll need to use the Anker multiport USB adapter to use a keyboard **and** a mouse. The Raspberry Pi Zero W only has one micro-usb port.
     - You can get away with using just a monitor and keyboard, but if you are not comfortable navigating with a keyboad only, it'll be difficult.
6. Lastly, making sure the the power adapter for the Pi is plugged in to a power source, and verifying the switch on the adapter is in the **"off"** position, connect the power cable into the Pi.

7. Now, turn the power switch on.

   **NOTE!** Make sure not to turn the device off, or on/off/on, otherwise the **"ssh"** and **"wpa_supplicant.conf"** files will not be in your boot directory on the SD card anymore. If, for whatever reason, the Pi loses power after putting those file in the boot directory, you will have to go back and add them, as in step **2.3**. This is **especially** important for ***headless*** users (users with no monitor).

   **NOTE!** This is where ***headless*** users will have to remotely connect to the Pi, while people who have monitors, mice, and keyboards won't have to remotely connect. For those who aren't connecting remotely, skip ahead to step **3.2**

# 3 Accessing and updating Raspberry Pi OS

Now, there are different ways to remotely connect with the Raspberry Pi if you are a ***headless*** user. Unfortunately though, you will have to connect to the Pi using **SSH** the **first time**. After that, you can install a remote server on the Pi so you can connect with it using a program with a GUI. I recommend using SSH, though, as it is a ***much*** quicker connection.

## 3.1 Remote connection via SSH

### 3.1.1 Installing Raspberry Pi Finder and finding Pi's IP address

The goal with this step is to find the **local IP address** of the Pi. There are a lot of different ways to do this. If you are computer savvy, go ahead and find the IP address of your Pi and ingnore this step.

1. The easiest way to find the IP address of your Pi, if you don't know networking or computers that well, is to use the **Raspberry Pi Finder** by Adafruit.

2. With your main computer, go to this websiteto download the application for your OS:
   `https://github.com/adafruit/Adafruit-Pi-Finder/`

3. Scroll down and click the link that says **"Download the latest release"**

4. Scroll down to **"Assets"** and there you will see the .zip files of the program for the different OSs.

   - **"osx"** is for Mac users.
   - **"win32"** is for Windows user.

5. Download the .zip file for your system and then unzip it when finished downloading.

6. Run Raspberry Pi finder.
7. Click **"Find my Pi!"** for the program to locate your Pi. Wait a few minutes if it doesn't find it immediately. Sometimes it can take quite a while!
8. The IP address should be listed when finished. It should look something like **"192.168.1.XXX"**.
9. Use the IP address to connect to the Pi.

#### 3.1.2 SSH connection

- For Windows users, you will want to use the **Command Prompt**.
    1. Press the ***Windows*** key on your keyboard, type **"CMD"**, and **Enter**.
    2. In the Command Prompt, type the command below making sure to substitute "192.168.1.XXX" with the IP address found in step 8

```
ssh pi@192.168.1.XXX
```

- For Mac users, you will want to use the ***Terminal***.
    1. Press the ***Command + Spacebar*** keys on your keyboard, type **"Terminal"**, and **Enter**.
    2. In Terminal, type the command below making sure to substitute "192.168.1.XXX" with the IP address found in step 8

```
ssh pi@192.168.1.XXX
```

1. For both Mac and Windows users, you should now see a prompt in the command line asking for the Pi's password.

   By default, the password is **"raspberry"**.

   The command line won't show the password while you are typing it, nor will it show placeholder characters. You will need to just type it and **Enter**.
2. If all went well, you should see that you've connected to your Pi via the command line interface (CLI). You should see the text:

```
pi@raspberrypi/:~ $_
```

3. There will also be a warning that the Pi's password hasn't been changed. We will want to change that, but we are not going to do that right now.

### 3.2 Update and Upgrading Raspberry Pi OS

Here we will be updating the Raspberry Pi. This is the first thing we are going to want to do to make sure there are now errors later on. We will need to implement a few commands into the Pi's command line. Don't be afraid! Its easy!

1. First we are going to want the Pi to talk to the official Raspberry Pi servers to get the latest version list of our programs on the Pi. In your SSH session, type the following command:

```
sudo apt update
```

2. Secondly, we want the Pi to compare the version list with its current packages and programs and update where needed. In your SSH session, type:

```
sudo apt full-upgrade
```

3. You will be asked if you are sure you want to upgrade. Type **"y"** and **Enter**.

4. Once it is finished, it will show this once again:

```
pi@raspberrypi/:~ $_
```

5. Congratulations! Your Pi has been upgraded!

## 4 Configuring the Pi

- Hopefully you still have your current SSH connection going with your Pi. If not, try to create one. If you exited the Command Prompt/Terminal, and severed the SSH connection, just reopen them and reconnect via SSH as in step 3.1.2.

- If **power** was severed from the Pi, you will need to repeat section 2.3 over again. The Pi discards these files after it boots up, so if you shut off the Pi, or lose power, you'll have to re-add them to the boot directory.

### 4.1 Changing the Pi User Password

As a security measure, since your Pi is in your WiFi network, you'll want to change the password for the Pi.

1. Run the Raspberry Pi configuration utility by using this command in the CLI:

```
sudo raspi-config
```

2. Navigate to **"Change User password for the 'pi' user"** and hit **Enter**.
3. It will prompt you that it is going to ask for the new password. Press **Enter**, and type your new password followed by **Enter** again.
4. Verify the password by typing it again.
5. Your Pi now has your new password. Don't forget it!

## 4.2 Network Options

We want to make sure the Pi's network options are configured properly so we don't have to add a **wpa_supplicant.conf** file to the boot directory when booting anymore.

1. While still in the raspi-config utility, navigate to **"Network Options"**.
2. Navigate to **"Wireless LAN"** and hit **Enter**.
3. It will prompt you to enter your WiFi **SSID**. This is the name of the WiFi network. Enter it and press **Enter**.
4. Next it will ask for the WiFi password/passphrase. Type that in and hit **Enter**.
5. If done correctly, it will notify you it was successfully done via the CLI.
6. Your Pi now has the wireless network configured properly.

## 4.3 Boot Options

This next configuration is more for fun and is **OPTIONAL**. We are going to make the Raspberry Pi **"text boot"** instead of just showing a splash screen. This is fun because it shows you the boot process via the CLI so you can see ***exactly*** what is starting during boot up!

1. While still in the raspi-config utility, navigate to **"Boot Options"**.
2. Navigate to **"Splash Screen"**.
3. It will prompt you if you want to see the **splash screen** at boot. Select **"NO"**
4. It will then tell you that the splash screen at boot is disabled. Woohoo!

## 4.4 Localization Options

This may or may not be a problem for some people. I had to make sure my time zone was set correctly. I believe by default the Pi's time zone is set for Europe.

1. While still in the raspi-config utility, navigate to **"Localisation Options"**.
2. Navigate to **"Change Time Zone"**.
3. In a few seconds it will prompt you to choose your **geographic area**. Select whichever corresponds to yours. In my case it was the US.
4. It will then tell ask you what your **time zone** is. Select what applies. In my case is was Pacific Ocean.
5. Then, it will flash the CLI with the Coordinated Universal Time (UTC) and your time zone's time and go back to the configuration utility.

## 4.5 Interfacing Options (enable SSH)

**IMPORTANT** We need to make sure we enable SSH in the Pi's configuration. This is extremely important and allows us to connect to the Pi via SSH in all future instances without having to add a ssh file to the boot directory.

1. While still in the raspi-config utility, navigate to **"Interfacing Options"**. Remember where this is located because we will need to access this later on.
2. Navigate to **"SSH"**.
3. The Pi will then ask if you want the **SSH server** enabled. Select **Yes**.
4. Wait a few seconds and the Pi should notify you the SSH server is enabled.

## 4.6 Virtual network Computing (VNC) Option

**NOTE** For those who find the CLI a bit tricky, or just don't like it, you can enable a virtual network computing software called RealVNC before shutting down the Pi. This will let you control the Pi via a graphical user interface (GUI), like what people are normally used to on MacOS or Windows.

1. While still in the raspi-config utility, navigate to **"Interfacing Options"**.
2. Navigate to **"VNC"** and select it.
3. The Pi will prompt you if you want the **VNC Server** enabled. Select **"Yes"**.
4. Wait a second and the Pi should let you know that the **VNC Server** is now enabled. This server will start automatically when the Pi boots up.

5. You still need to download **RealVNC *Viewer*** on the computer you want to remotely access the Pi with.

6. **RealVNC Viewer** can be downloaded at:
`https://www.realvnc.com/en/connect/download/viewer/`

7. Download the client that is for your OS and then install it.

## 4.7 Finishing Up

You Pi should be configured now! When the Pi does get turned off and turned back on, it should boot and connect to your WiFi and allow you to SSH into it. Now, we still need to close the Pi's configuration utility and shut down the Pi.

1. While still in the raspi-config utility, navigate down as far as it lets you **(About raspi-config)**.

2. You will have to press the right arrow key to get down to **"FINISH"**. Tricky and a little unintuitive, I know...

3. Select **FINISH** and it should exit the utility back to the CLI.

4. Next, run this last command in the CLI to shutdown the Pi:

```
sudo shutdown -h now
```

5. Soon the Pi will shutdown and you'll get a message in your Command Prompt/Terminal something along the lines that the connection was closed or lost.

6. Flip the switch on the power supply to the Pi to make sure power is not going to the Pi.

**CONGRATULATIONS**! You done configuring the Pi. *Whew...*