

## Setting up the Raspberry Pi

It is possible to use a Raspberry Pi as a full computer. That is, you can connect it to a monitor, a keyboard and a mouse and have a ‘normal’ running system. I am not going to use it that way. Rather, I will describe in the following section how to set one up so that it is ‘headless’. In this mode, instead of having a monitor, keyboard and mouse, you use your normal main computer to operate the Raspberry Pi remotely via wireless. The Raspberry Pi will just be a window on your main computer’s screen.

You will need to buy a Raspberry Pi with Wi-Fi. All currently built versions of the Raspberry Pi have Wi-Fi built in except for the simple Zero. The Zero W model does have Wi-Fi. Raspberry Pi’s come in several different varieties, with different costs. The most powerful one, at this time, is the 4A which costs about \$35; the least powerful is the Zero W which costs \$10. Unfortunately, this latter small computer is in such great demand that retailers are limited to sell one per customer order. The Zero W will operate somewhat slower than the 4A but if you don’t mind waiting a few extra seconds to get a graph of impedance or admittance, then the Zero W may be the machine for you. Both the Raspberry Pi Zero W and the 4A have WiFi built in and I’m assuming you will want to connect to your LAN using WiFi.

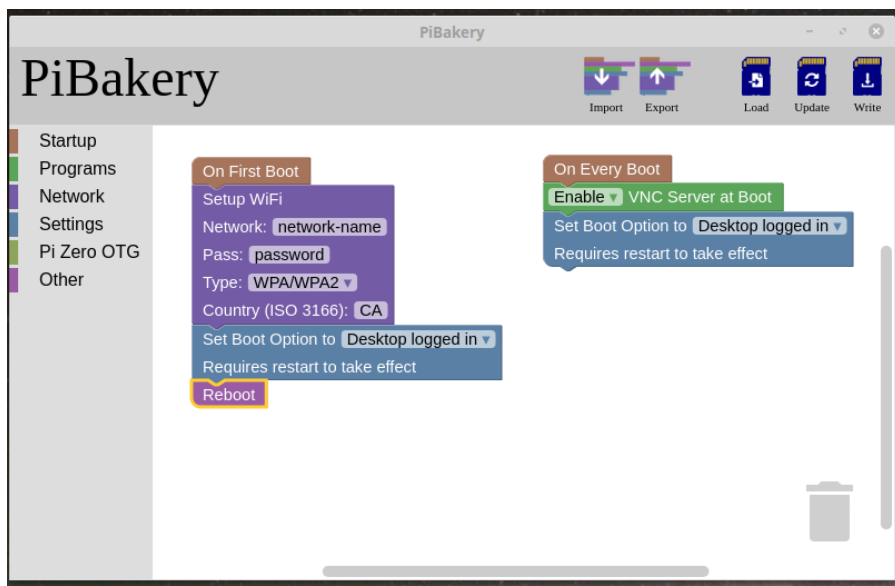
You will also need a micro SD card of at least 8 GB in size and, if you do not already have it, an adapter to let you plug the micro SD card into a USB connector on your main computer. The micro SD card should be Class 10 or better. I’ve noticed that, locally, I cannot buy a micro SD card with less than 16 GB capacity. Adafruit<sup>i</sup> in the USA or Canakit<sup>ii</sup> in Canada, are two of many companies which can supply the Raspberry Pi, the micro SD card and the adapter to a USB connector. You will also need a 5V power supply, with a micro-USB connector, for the Raspberry Pi. This power supply needs to be able to supply at least 500 mA for the Zero W and perhaps 1 A for the 4A. Many cell-phone chargers will work very nicely for these. Alternatively, one of the little USB battery packs meant for cell phones will provide several hours of operation.

Setting up involves a number of steps. You will need to download the operating system from the Web, burn it into the SD card, configure the

Raspberry Pi and finally download and install the programs for the impedance meter. This will all be a bit tedious but the process is relatively straight-forward and just requires a bit of patience.

Firstly download the needed files; they are all free. The programs I wrote are available on the ARRL Web site; they are all in a single compressed file named 'R-Pi\_files.zip'. You will also need a program to write the operating system to your micro SD card and I recommend one called PiBakery which is available at their PiBakery site<sup>iii</sup>. This will be a big download because PiBakery also contains the Raspbian operating system which it will write to the SD card for the Raspberry Pi. PiBakery allows one to pre-configure some features of the Raspberry Pi operating system before writing it to the SD card and we will take advantage of this feature. The PiBakery web site has complete instructions for how to use it and it is worthwhile reading these. Finally, you will need to install a VNC client (viewer) on your computer; you will use this to connect to the Raspberry Pi and to control the impedance meter. I recommend RealVNC<sup>iv</sup>; just download the version appropriate for your computer's operating system.

All these files, when downloaded, will likely appear in your Downloads folder. To install the VNC client (Viewer), just double-click on the downloaded file. For the 'R-Pi\_files.zip' file which is also in your Downloads folder, for the moment, just extract the three files in it into the Downloads folder.



The PiBakery file you downloaded is the installation file; just double-click on it to install the program. After it has been installed, just click on the icon of that

name and a window will appear. Click on the 'Import' icon and in the file dialogue which appears, select the 'Pi\_Z\_meter.xml' file which is in your Downloads folder. This figure shows what this should now look like after the Pi\_Z\_meter.xml file has been imported. In the purple area on the left, replace 'network-name' with the SSID name of your wireless network, and also replace 'password' with the correct one for your network. Now, put your micro SD card in its USB adapter and plug it into your computer and then click on 'Write' in the PiBakery window. A sub-window will pop up showing your SD card in it; this will likely be drive E: under Windows. Then, click 'Write' and the program will now write the Raspian operating system into the SD card along with the configurations needed to connect to your WiFi network and to start up the VNC Server in the Raspberry Pi. In a Windows machine, when you first plug in the SD card, you will get lots of ancillary windows popping up, asking if you want to format the drive and other things. Just ignore and close them and wait till PiBakery has finished writing to the SD card. This will take a few minutes.

When the writing of the SD card is done, you can now remove it and plug it into its socket on the Raspberry Pi. Then, the Raspberry Pi can be turned on by connecting the power supply to the micro-USB socket closest to the end of the board. The little green LED will blink many times as the Raspberry Pi boots up the first time, connects to your network, and eventually settles down to a steady glow. This first boot might take several minutes.

Now, in order to connect to the Raspberry Pi via VNC, you have to find out what its URL is on your LAN. If you are accustomed to logging into your router, you can do that and find out what devices are connected to it and what their local address is. If you are not, and most of us are not, you will need to run some program which will tell you what is connected. I recommend the 'Angry IP Scanner'<sup>v</sup>. It is free and there are versions for Windows, Linux or Macs. When you scan your network, you need to look

for a device called 'raspberrypi'. Make a note of its address; on my machine, it came up as 192.168.1.29.

At this point, you're almost there. You just have to connect to the Raspberry Pi via VNC and you do that using the VNC client you downloaded and installed earlier. When you start this program, you should click on 'File > New Connection' and then fill in the IP address you noted earlier. You can give it a name if you choose but leave all the other text inputs at their default values and click on 'OK'. It will ask for a user name, this is 'pi' and a password, which is 'raspberry'. Click on the box to remember the password. When a connection has been made, a window will appear on your screen and this is the display for the Raspberry Pi. For the first connection, the Raspberry Pi may take you through a large number of steps including updating and this will take some considerable time. Be patient and recall, if you can, what it was like in the old days and you were setting up a Windows 98 machine for the first time. One of the steps will be to ask you to change your password. If you do change it from 'raspberry', bear in mind that you will have to amend the setting on the VNC client the next time you log in. After you're done, the Raspberry Pi will reboot and you will have to reconnect , via VNC, again after it has done so.

The next time you connect, the Raspberry Pi is ready to operate. By default, it comes up with a window which is just 720x480 pixels. This is a bit small but you can adjust it to make it any size which will fit inside your computer's normal display. To do so, click on the raspberry icon at the top left, select 'Preferences > Raspberry Pi Configuration' and you will have a window which has text box labeled 'Resolution' which you can set. Unfortunately, changing the resolution requires a reboot before it is activated. However, be patient and you can eventually get the Raspberry Pi's window a convenient size. At this point, you have a working Raspberry Pi computer and can do things like change the desktop background (right click anywhere on the screen and go to Desktop Preferences) and/or explore with the Raspberry Pi as a computer in its own right. It has a decent file manager, a

web browser and an email client and you can install a printer, etc. For some things like the Web browser, it will be painfully slow ... but, it is not bad for a computer costing less than \$50.

The last step is to install the programs to control the impedance meter. Before doing so, some utility programs are needed from the internet and they can be installed by invoking the terminal (click on the fourth icon at the top left and it will open a 'terminal') and typing, at the prompt:

```
sudo apt-get install gnuplot feh python3-scipy
```

You will see a lot of activity and you will have to respond (type a 'y') to a question and these utilities will be installed.

You will need to make the serial port in the R-Pi available to you as the user, pi. To do so, type:

```
sudo usermod -a -G dialout $USER
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The other programs you will need to install are from one of the files you extracted from the ARRL download; the folder 'impedance\_meter'. If you hover your mouse icon at the top centre edge of the Raspberry Pi window, a pull-down menu will appear and, in the middle of this is an icon showing two arrows in opposite directions. If you click on this, a sub-window will appear to allow transfer of files from your computer to the Raspberry Pi. Click on 'Send files' and a file dialogue will appear allowing you to point to the 'impedance\_meter' folder which is now in your computer's Downloads folder. Click on this file to highlight it and then click on OK. The file will now be copied from your computer and will now appear on your Raspberry Pi window on its Desktop.

Now, on the Raspberry Pi, you will need to move this folder from the Desktop to the home folder: /home/pi. To do this, click on the icon of the file manager icon on the Raspberry Pi; this is the third from the left icon on the top row and looks like two file folders. This will open a window showing the files on your Raspberry Pi. In the left column, click on the icon which says

‘pi’ (it is probably already highlighted) and the panel on the right will show the contents of this folder. Simply drag the ‘impedance\_meter’ icon on the Raspberry Pi desktop into this right-hand panel. Now, double-click on the ‘impedance\_meter’ icon, in the right panel where you put it, and the window will now show you the contents of that folder. One of these will be a file whose icon is a large red ‘Z’ and a label saying ‘z\_meter’. Drag this onto a free spot on the Raspberry Pi desktop. That’s it, you’re done! To run the various z-meter programs, just start by double-clicking on that icon on the Desktop. For the Raspberry Pi 4A, you connect to the z-meter with a normal USB to micro-USB cable. For the R-Pi Zero W, you need a USB cable with a micro-USB connector on both ends.

The first thing you will want to do is to calibrate your impedance meter, with a good termination in place, using the calibration program. I did not include this program as one of the programs you can invoke normally. Instead, using the file manager, you need to navigate to the ‘impedance\_meter folder’ and there, double-click on the ‘calibrate’ icon. This icon shows a gear wheel. You will be asked how you want to execute this file so select ‘Execute in Terminal’. A terminal window will appear and the program will start its long execution. This calibration can take up to an hour or so ... but, you only have to do it once.

- i <https://www.adafruit.com/>
- ii <https://www.canakit.com/>
- iii <https://www.pibakery.org/>
- iv <https://www.realvnc.com/en/connect/download/viewer/>
- v <https://angryip.org/download/>