

Raspberry Pi-Zero

C. W. Andreasen, rev 10/8/2021-A

The Raspberry Pi-Zero is very interesting. It has amazing power and includes built-in Wi-Fi and Bluetooth capability. It is tiny, roughly one inch wide and two and a half inches long. Assuming you have another computer and a Wi-Fi connection, once set up, the Pi-Zero has no need for any connection beyond power. Uses are only limited by your imagination.

One can also, if desired, purchase various ‘Hats’ for different capabilities.

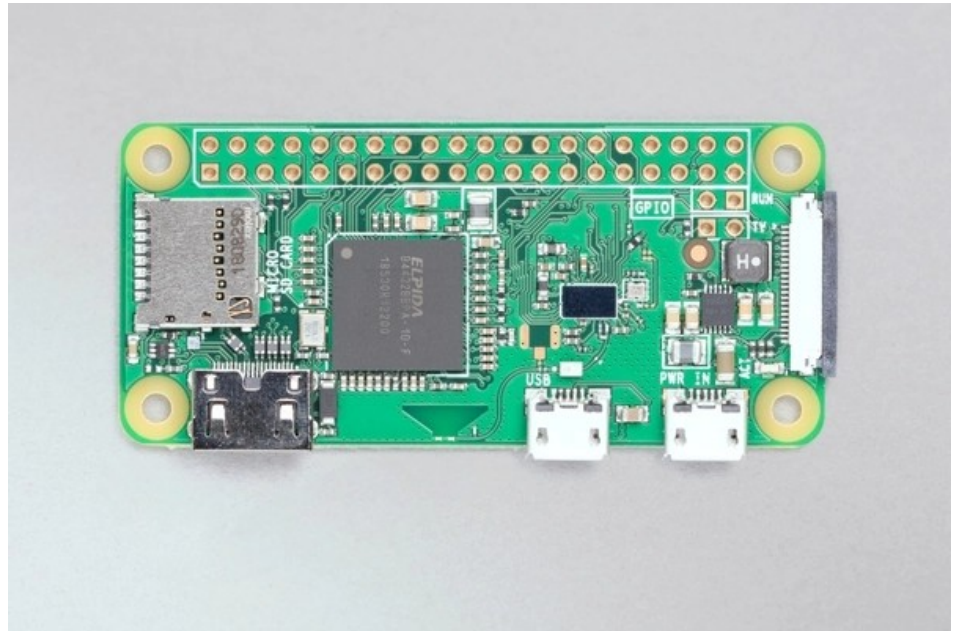


Figure 0: Raspberry Pi-Zero

The Pi-Zero processor is a single core processor with a one GHz clocking speed. There is one video connection (mini-HDMI), one USB connection (micro USB and a power connection, and of course the slot for the microSD chip. It has only 440 MB of RAM (remember the original PC had only 680K of memory, later expanded to 1 MB). The Pi-Zero is way more powerful than computers of the age when the PC was introduced by IBM. In fact the Zero will do almost anything a desktop Linux computer can do, limited only by System RAM available and the speed that in some cases would be slow. There are two ways to set up the operating system, The first is the normal recommended Pi OS which does not include all of the applications like LibreOffice, but has the normal desktop.

The second way is to load the version that has no desktop, just the command console, better known as Terminal or Command Prompt. Both are fine depending on what you are doing.

The desktop version uses up a lot of system memory and when installed it leaves only about 25% of the system memory for applications use.

The Console mode leaves about 75% of the system memory for applications.

The problem is most of us are comfortable with the desktop and not really up to living with the command prompt level.

I have found a solution. Install the desktop version and use it as needed, but the desktop (GUI) can be turned off and will free up the memory. To do this you use the program [sudo] **raspi-config** and one of

the menu items allows you to boot up in desktop or console mode. One can go back and forth, but each time it is changed the system needs to reboot.

raspi-config

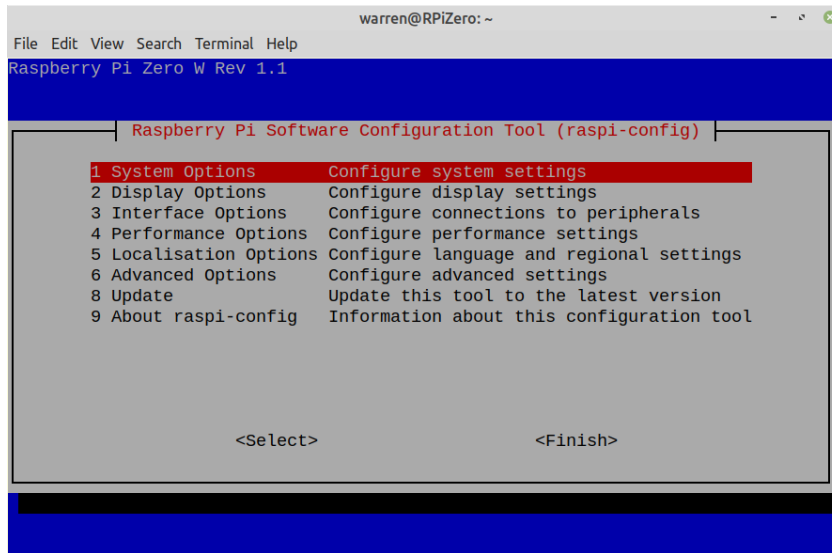


Figure 1: First Screen

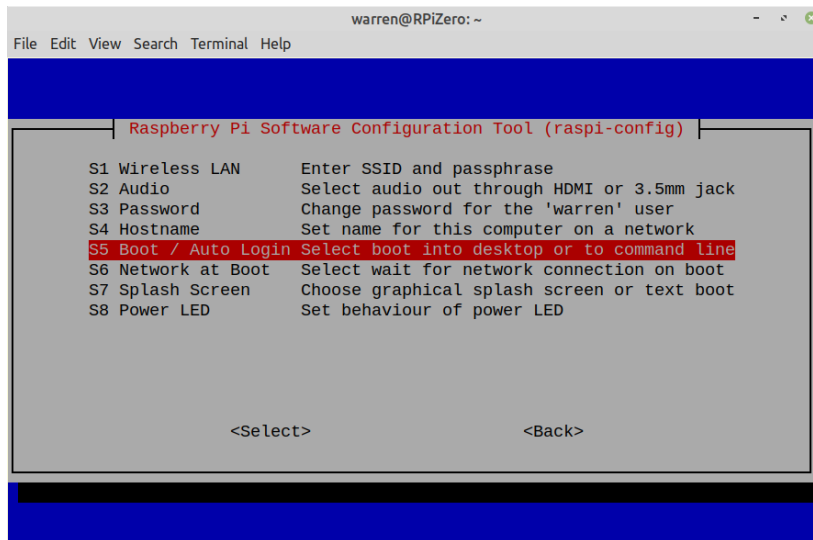


Figure 2: 2nd Screen

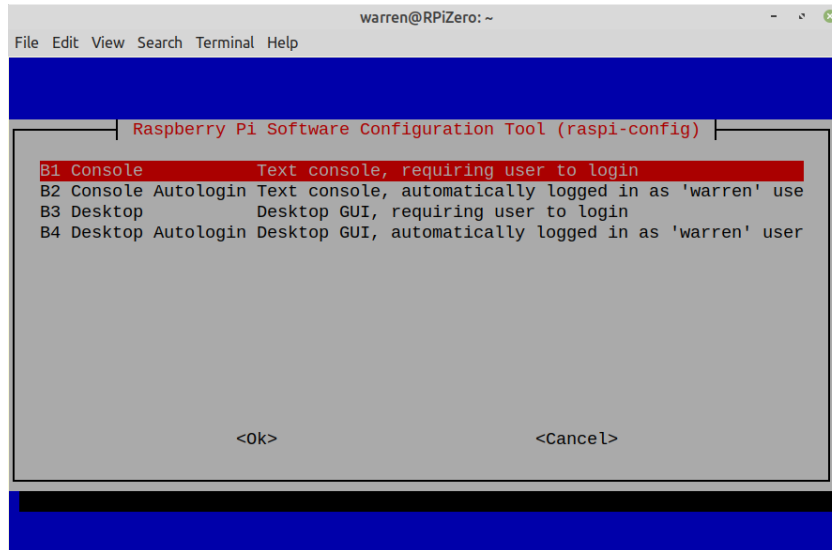


Figure 3: 3rd Screen

Installation and Set-Up

For initial setup you need a monitor and a keyboard. Be ready to connect to the Internet via the Wi-Fi network after you plug in the microSD chip that contains the install software, and the installation starts. At the appropriate time it ask for network name and passphrase.

Turn on power and answer questions when asked.

Once installed, for the desktop you want a mouse. Since there is only one USB port an external USB Hub is needed to allow both USB mouse and keyboard to work. Use a 4 port hub so you can use a keyboard, mouse, and a USB to micro SD adapter so backups can be done. If a powered hub is used then you can also handle other devices like memory sticks (Thumb Drives).

About the Raspberry Pi-Zero

The Pi-Zero is the perfect computer for running a dedicated task that runs a program at the system level. It has all the power of the Linux Debian operating system and without the Graphic User Interface that eats up almost all available memory, and makes it run slower, it is a very capable computer.

I have identified a couple of uses for this tiny computer and one of the most interesting is to use it for your very own, private and secure Dropbox, or Cloud Server. You can place it anywhere it can get power and be in range of your Wi-Fi network. Depending on what size of microSD you use you have available a mass-storage device. In fact the computer can be doing other dedicated task at the same time. If you should care to pay for it, you can stick in a TB microSD chip. The computer itself uses such a small amount of space that almost all space is available for file storage. In the 1TB case the memory would cost several times the cost of the computer itself... it would be the most expensive part of the system. I am using a 'cheap' 35 GB memory chip and the system is using less than 2 GB.

Another use is as a web page server. For testing I uploaded my k7cwa.me web page to it, after installing Apache2, and my page at 1.6 GB of data. When accessing the page via my network, it looks just as good, and is as fast (actually faster), as my page on the Internet does... I can tell very little difference.

Since I have the GUI installed, but turned off, all work is done at the terminal level, so I disconnected the keyboard and monitor and now access it using SSH from my 'big' computer. I have to keep reminding myself I am not on a 'big' computer, but on a 2 1/2 inch by 1 1/8 inch board, mounted in a small case that has only one cable (power) connected to it. I can place it anywhere in the house and forget about where I put it.

Working at the terminal level requires one to learn some new ways of doing things. They are just a different way to do things you have always done at the menu level.

One important command is 'sudo **adduser**' which will add a new user and you will be prompted for full name, various information you don't need to fill in, and of course a password. The password can be easily changed later with the command '**passwd**' where you are prompted for the existing password, then the new one (twice). I recommend you add yourself as a user with sudo. pi and root group privileges and change the Pi password away from the default "raspberrypi".

This new user must be given privileges before he can do anything, you use the format:

'sudo adduser [username] [group]; so 'sudo **adduser john dialout**' would add user john to the dialout group which is needed if you want to do email. Everybody should belong to the dialout group.

If you are going to install Apache web server '**sudo apt install apache2**'. The install will automatically add **www-data** to the group list. All files in the HTML section (that was added by the apache2 install) must belong to the www-data group, otherwise people connecting from the Wi-Fi won't have permission to view the files.

There are many commands, like 'sudo reboot' that are very useful. I suggest you search the Internet for commands you need. One such place to look is; <https://raspberrypitips.com/raspberrypi-commands/> which shows how to use 57 different common commands.

Another very useful command is go to the top of your web area and make yourself the owner and the files group of www-data. Say you go to 'cd /var/www/html' and you do this command:

'sudo chown -R [logon name]:www-data *' (no brackets or quote marks, but fill in the desired owner name logon name). This will set ownership of all files and directories and sub-directory/files as owner specified and all belong to the www-data group that allows any browser user come in from the network and view the files. Web users are automatically a member of the www-data group. Just for understanding, that command line breaks down as follows: chown is Change Owner. -R (must be uppercase as shown) says to do all sub-directories also, Then we have owner:group which sets both, and finally the ' * ' means any file or folder (everything). If you use a file name there it will change only that file, and you can use other wildcard combinations like *.html for only html files. It is best to use a folder name instead of a wildcard as shown as it is easy to accidentally change files that you don't

want to change. Select a folder and the -R will get that folder and everything contained, including sub-folders and contents.

Follows is a list of some of the pro's and con's to using a Pi-Zero.

Pro List some of the good points

- Very inexpensive. Full price with case, power supply, and everything else needed, including state tax, on Amazon, is less than \$39. The computer in the normal version, bare computer, can be had for less than \$20 and the version 1 without Wi-Fi or Bluetooth can be had for \$5.00. I recommend the newer model version with a full kit of accessories.
- Built-in back-up software (clone)
- Built-in wireless adapter and Bluetooth adapter. No worry about a LAN connection.
- When working in the shell without the GUI the system is quite fast. Programs like NANO (text editor) work full speed at the shell level. There is also a built-in compiler which will compile source code.
- Software detects and connects network printers (with the GUI installed anyhow)
- Tiny and low power and small size, roughly one inch wide and two and a half inches long.
- Free operating system downloaded from Raspberry Pi's web site.
- Cables and adapters provided with the kit.
- Source code compiles quite nicely on the Zero using the './configure, and 'make' commands. Of course there is also the dpkg command.
- Apache2 web server installs nicely and when using the web section, the results are indistinguishable from a main-line system on the Internet.
- Once set up the computer runs fine with no keyboard, no monitor, no mouse with just the power connection and the Wi-Fi wireless connection.

Con List

- No Ethernet connection so one *must* use WiFi (unless you buy a special Ethernet Hat).
- The built-in Wi-Fi is low band only, does not detect the faster high band.
- One mini HDMI output for a monitor, but an adapter is provided with the kit so a regular HDMI cable can be used for the monitor.
- It is difficult to use applications launched from the desktop because the GUI eats up a lot of the system memory. Internet browsing is not really an option, it is slow and this makes it hard to download programs via the program manager or browser.
- The GUI has limited usefulness because of system memory issues.

- The microSD chip is not accessible without removing the Zero from it's case.
- The low clock rate (relatively) and read/write speed of the MicroSD chip make for long transfer times when uploading or downloading large files. Uploading time is at about 10 minutes per Gigabyte. Download time is about the same. Normal single file transfers seem almost instantaneous.
- If a USB memory stick is used, the system may not see it and it is not mounted. This is because the USB port is not capable handling the power. With an external powered hub it does work.

Another thing of note. When the system uses an external powered hub, it not only solves the port loading problem, but it also powers the Pi back through the USB connection. A separate power cube for the Pi is no longer needed.

One last thing; to use the network to connect to the Pi you must know the IP address. One way you can find out what it is, is from the command prompt. Enter the command **ip addr** and you will get something like this:

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group
default qlen 1000
```

```
link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
```

```
inet 127.0.0.1/8 scope host lo
```

```
valid_lft forever preferred_lft forever
```

```
inet6 ::1/128 scope host
```

```
valid_lft forever preferred_lft forever
```

```
2: wlan0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP
group default qlen 1000
```

```
link/ether b8:27:eb:fa:68:7b brd ff:ff:ff:ff:ff:ff
```

```
inet 192.168.1.14/24 brd 192.168.1.255 scope global dynamic noprefixroute wlan0
```

```
valid_lft 79657sec preferred_lft 68857sec
```

```
inet6 fe80::6a11:355f:31b0:31e/64 scope link
```

```
valid_lft forever preferred_lft forever
```

On the line that starts with “inet” in section 2, you find the IP address. As you can see, mine is 192.168.1.14 - the /24 is the mask value, but you do not need that for anything.

Another way, maybe less confusing is to use the command **ip route** which will return something like this:

```
default via 192.168.1.1 dev wlan0 proto dhcp src 192.168.1.14 metric 302
```

```
192.168.1.0/24 dev wlan0 proto dhcp scope link src 192.168.1.14 metric 302
```

The last IP address at the line ends is the unit's IP address.

Groups

One thing hard to find, is what are the names of available Groups to which a user can belong. Keep in mind, new groups can be created, and many that exist now are not needed for anything, but here is a more-or-less complete list from my Pi-Zero:

**root, daemon, bin, sys, adm, tty, disk, lp, mail, news, uucp, man, proxy, kmem, dialout
fax, voice, cdrom, floppy, tape, sudo, audio, pulse, dip, www-data, backup, operator
list, irc, src, gnats, shadow, utmp, video, sasl, plugdev, staff, games, users, nogroup
systemd-journal, systemd-timesync, systemd-network, systemd-resolve, input, kvm
render, crontab, netdev, messagebus, ssh, bluetooth, avahi, i2c, go, lightdm, rdma
rtkit, lpadmin, ssl-cert, pulse, pulse-access, scanner, saned, colord, systemd-coredump**

If you want to see what groups you have and who belongs to each group, go into terminal and type the following command `<sudo cat /etc/group | less>` (no brackets). There is much more than can fit on one screen but it will stop when full, and each time you hit the space-bar it will advance one screen. You can also use the arrow keys to move forward and back a line at a time. When done just type the letter Q to quit.

ssh:x:121:warren,k7cwa

Is what one entry looks like on my Pi. This one shows group ssh has two members, warren and k7cwa. The x and the number 121, I do not know for sure what they are for. The number seems to be assigned more or less sequentially and I think the system uses the number rather than the text, the text being for humans use. Root is always 0 (zero), pi is 1000, and pi is a member of the root group. I assigned myself to the pi group and found my group was assigned the number of 1001.

More about Groups

A group is just a name, it does not ‘do’ anything. It does add an extra layer of security. A program or application is assigned to a group, you must also belong to that group to use it. Every user can belong to any and all groups, and in fact each user automatically becomes a group. If you subscribe to a person-group then you inherit all of the groups they belong to also. Root is set up as a member of all groups so if you belong to the sudo group you have pretty much everything if you know the root password. If you belong to a group then you would not need to use sudo and enter a password to access the file or application.

Normally a person is not assigned the group of ‘root’ but instead is assigned to the ‘sudo’ group. The sudo group members can enter the command sudo and get temporary root access. A common user who should not even be in the terminal level might not belong to the sudo group so this person cannot do anything to damage the system. Such a person would be limited to just his or her own account and would not be able to open any files they do not own.

Every file has properties and under Permissions the file is assigned to an owner and a group. If you are not the owner, and do not belong to the same group as the file, you cannot open the file. It takes root privileges to change ownership and/or group. If you create a file it will automatically be assigned to you and your group so unless changed, It is your file and you have full privileges in dealing with that file, and nobody else can touch it (without root powers).

There are several groups to which we do need to pay attention. For example the **dialout** group. You must be a member of the dialout group to be able to send email, **www-data** to access web files that you might not own, so you can work on a web page, **sudo** to allow temporary root privileges. By all means add yourself to the **ssh** group. Make sure that in the raspi-config program you **enable SSH** there also, if you don't you will not be able to make ssh work. You can enable it in the configuration settings in the GUI menu also (see figure 4).

Since most of us working on the system are the owners, normally we just give ourselves all groups and forget about it. It does not hurt to have groups that are never used but it is not so good to need a group and not be a member of it. It is better to have it and not need it than to need it and not have it.

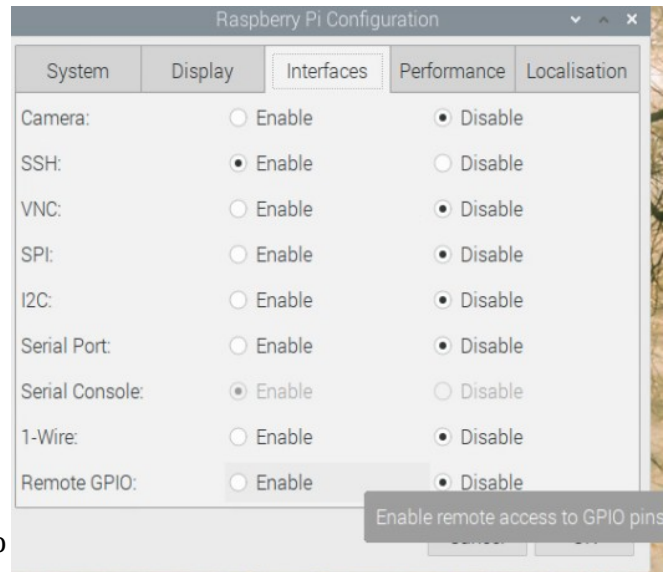


Figure 4: GUI Pi Configuration Menu

All experts say you should never log on as root, but you should create your own account. Of course you could cheat and change user pi to your name. Note that while pi is a root user, it is not the root, which is oddly enough called root and is not a logon account.

This “groups” information is not just for the Pi-Zero, it is for all versions of Linux and it is good to understand.

For the sake of security, change the default password for ‘pi’ from the standard “raspberry” to a secure password. Use adduser to create your own login name and password and use it. Make yourself a member of sudo, and pi and if you have loaded apache2, www-data, and throw in dialout, and you should be pretty well set to do anything

Of course you can just log on as pi, but where is the fun in that?