

Raspberry Pi Basic Setup

Memory card preparation: Before loading the operating system on the memory card, the card should be formatted with *SD Formatter*, a program specifically designed for secure digital memory cards. The formatting function available in the Windows operating system should not be used to format these types of cards.

Download the program from [{SDForm}](#) and install it. After installation, mark the shortcut (or the program itself) to Run as Administrator. Now, connect a card reader/writer suitable for a micro-SD memory card to the PC. Insert the SD or micro-SD memory card into the card reader/writer. Some micro-SD cards and older card reader/writers are incompatible, so it may be necessary to install the micro-SD card in a full-size SD card carrier or adapter and insert the carrier into the reader.

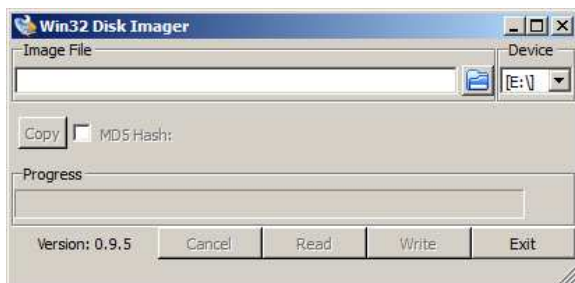


When using *SD Formatter*, generally select the *Full (Erase)* or *(Full Overwrite)* Format Type and set the *Format Size Adjustment* to ON. The time to format is related to the size of the memory card and may require several minutes. The Volume Label is optional and, if used, should reflect the name of the system used with the card (for example, Callisto-Pi) – the text is limited to 11 characters.

Raspbian image installation: Many systems use the Raspbian distribution, which is a version of Linux. It is necessary to download and install the distribution image on the memory card in a format that is compatible with the RPi. It is not possible to simply copy and paste (or drag-and-drop) the distribution image from a Windows PC to a memory card; instead, a special image writer program is needed. Suitable programs are Win32 Disk Imager [{WDImg}](#), HDD Raw Copy Utility [{HDDRaw}](#) and Etcher [{Etcher}](#). The instructions that follow are based on Win32 Disk Imager. Download and install the program and place a shortcut to it on the Desktop. Mark the shortcut (or the program itself) to Run as Administrator.

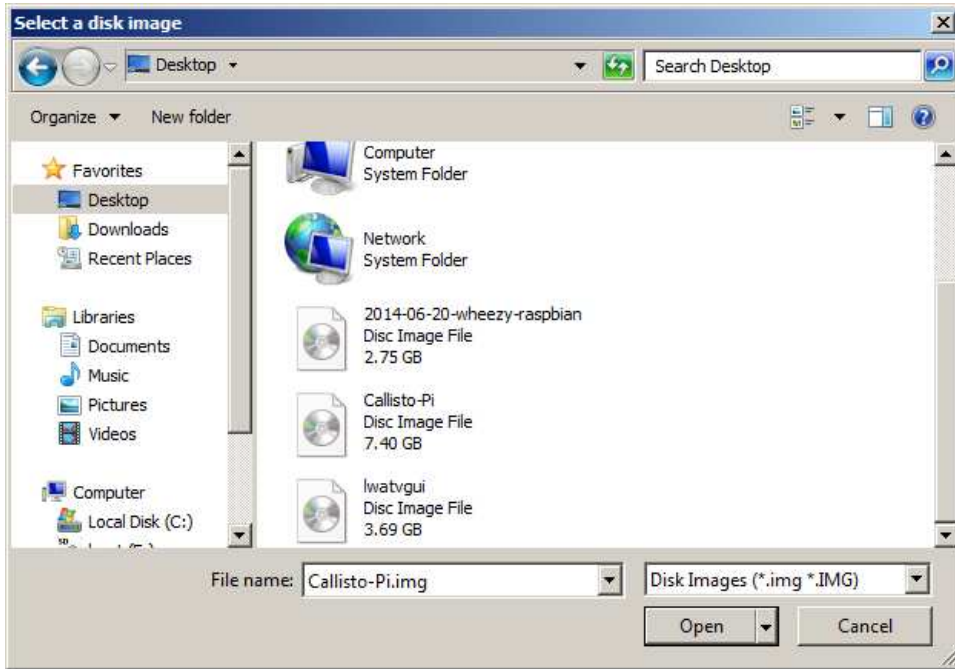
Now, download the Raspbian distribution from [{Raspbian}](#) and extract the *.zip file to the Desktop. Write this image to a 4 GB or larger micro-SD memory card as follows:

Determine card's drive letter from My Computer or Explorer and then open Win32 Disk Imager.

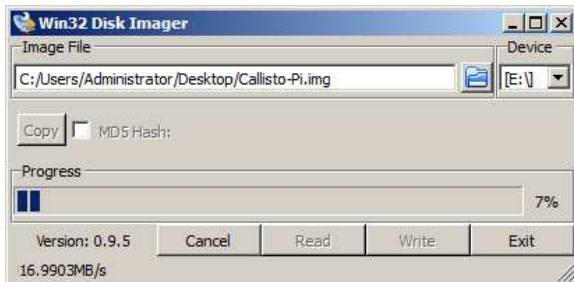


A drive letter is shown in the Device field in upper-right of Win32 Disk Imager. If you have more than one device plugged into the PC, select the letter corresponding to your memory card (drive letter E: in example above).

Click the folder icon to right of the Image File input field. Windows Explorer will open (below). Navigate to the location where the Raspbian image is located and select the file. Click Open. In the example below, the image file is located on the Desktop but it has not yet been selected in the File name field.



At this time you will be returned to the Win32 Disk Imager user interface. Click the **Write** button. After a moment the Progress bar will show the Write operation, which requires several minutes. A Class 4 memory card will require more time than a Class 10 card. Be patient.



When the Write process finishes, a Success window will pop up.



By default, Raspbian distributions prior to *Jessie* allowed Secure Shell (SSH) access using a terminal emulator, but later versions do not. SSH is required in all setups described in this document. Therefore, for *Jessie* and later distributions, it is necessary to place an empty text file on the memory card that will enable SSH. This file is not required for Raspbian distributions prior to *Jessie*.

Proceed as follows: After writing the Raspbian *Jessie* (or later) image to the memory card and before removing it from the Windows PC, prepare an empty text file named *ssh* with a text editor such as NotePad or NotePad++ (it does not matter what is in the file; it can be empty). Save the file without any extension (*ssh* not *ssh.txt*). Copy this file to the memory card using normal Windows file explorer copy/paste or drag/drop procedures.

Eject the memory card by right-clicking the drive letter in My Computer or Explorer and selecting Eject. Remove the memory card from the reader/writer.

Memory card installation: Insert the micro-SD memory card into the slot connector on the bottom of the RPi board. The contacts side of the memory card (see right) should face the board. For some RPi versions, the memory card connector slot is push-to-insert/push-to-release and is self-latching. The card cannot be inserted the wrong way. Gently push the card all the way in and release finger pressure; the card should remain in the holder and not spring out. To release, push again and the card will spring out. Other RPi versions use friction to hold the card; for these simply push the card into the slot until it stops and pull the card to remove it.



Network: Connect a high-quality Cat5 network cable between the RPi Ethernet connector and a LAN switch or router. The wired connection is used for provisioning. A WLAN connection can be installed later.

Power Supply: Before connecting a 5 Vdc power supply, read this first: DO NOT attempt to power the RPi using a USB port on a desktop or laptop PC or handheld device. Power measurements of the RPi model B+ showed < 1.5 W average dc load. However, when the RPi is booting and depending on connected peripherals, the measured load current can be > 670 mA (3.4 W), too high for a PC USB port.

The system should be powered by a well-regulated, low ripple, electrically quiet power source rated ≥ 2.0 A at 5.0 Vdc (≥ 5 W). Using a poor quality power supply will lead to unreliable operation so be sure it meets these requirements. One of the most common problems users have with the RPi is inadequate power supply current. To minimize electrical noise, it is recommended that ferrite beads be installed on the power cable (image below).



AC wall power adapter rated 12 W at 5 Vdc with North American ac input plug. One or more clamshell ferrite beads on the dc power lead may help reduce radio frequency interference from the switch-mode power supply. This image shows one bead on the right with three windings of the power lead. The Raspberry Pi uses a micro-USB connector for power. (Image © 2014 W. Reeve)

Power connection: Connect the 5 V power supply to the micro-USB connector on the RPi. Refer to the table below and watch the LEDs on the RPi board. If the red LED does not illuminate, there is a problem with the power supply. If the green Activity LED turns on and stays on, the memory card may be corrupted.

RPi LED Indicators

Condition		
Power off	Power LED, Red: OFF	Activity LED, Green: OFF
Power on, Boot	Power LED, Red: ON	Activity LED, Green: Flashes during boot
Power on, Ready	Power LED, Red: ON	Activity LED, Green: Occasional flash
Ethernet connector	Left LED, Yellow: ON 100 Mb/s, OFF 10 Mb/s	Right LED, Green: ON link established, Flashes activity OFF if no link

Note: Later, when it becomes necessary to remove power from the RPi, the RPi must be properly shutdown (just like a Windows PC). Never remove power without first shutting down the RPi. To shutdown, log into RPi as described in the next section using the SSH terminal. At the prompt enter:

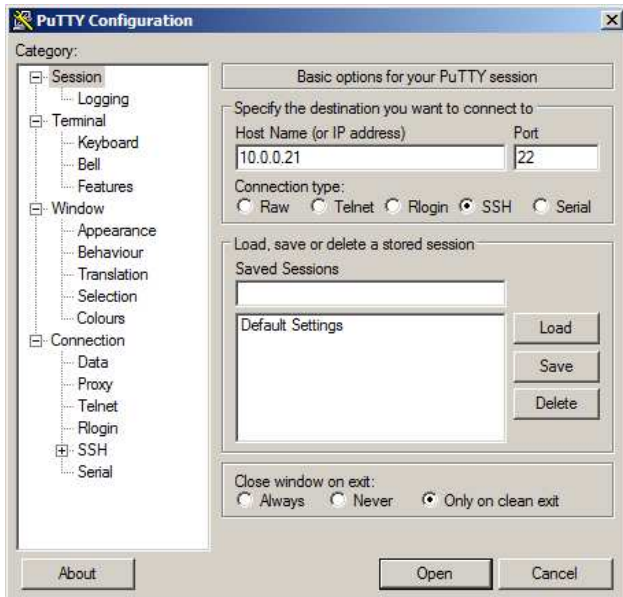
```
sudo halt
```

or

```
sudo shutdown -h -P now
```

All LED indicators on the RPi board except the red power LED will extinguish when the shutdown is complete, requiring only a moment. The LEDs on any Raspberry Pi HATs or daughter boards such as a GPS receiver board will not change. Power may then be removed from the RPi board.

Secure Shell installation: This guide is based on PuTTY [{PuTTY}](#), which should be downloaded and installed now on the PC to be used to provision the RPi. Open PuTTY and enter the RPi IP address into the Host **Name or IP address** field. Do not change the port (22) or Connection type (SSH). You can determine the RPi's IP address from your router LAN status screen or by using a program like Netscan [{Netscan}](#), Advanced IP Scanner [{AdvancedIP}](#) or AngryIP [{AngryIP}](#). In PuTTY enter a name for the session (example, GpsNtp-Pi) in the Saved Sessions field. You also can customize the user interface by clicking on the various entries in the Category window but you can do this later. Click the Save button to save the session settings.



```
pi@Callisto-Pi: ~
login as: pi
pi@10.0.0.37's password:
Linux Callisto-Pi 3.12.35+ #730 PREEMPT Fri Dec 19 18:31:24 GM

The programs included with the Debian GNU/Linux system are fre
the exact distribution terms for each program are described in
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the ext
permitted by applicable law.
You have new mail.
Last login: Thu Jan  8 06:05:46 2015 from 10.0.0.8
pi@Callisto-Pi ~ $
```

Upper-left: Screenshot of PuTTY configuration window with the IP address for a test setup. Your installation will have use a different address. Upper-right: Upon first connection, PuTTY asks for authentication; click Yes. Lower-left: When PuTTY is connected, the window changes to a simple command line interface. After login, you can make changes to the RPi as described in this guide.

Click Open. After authentication you will see the RPi login prompt in the command line interface. Enter the username and then the password. You will not see characters on the console as you enter the password.

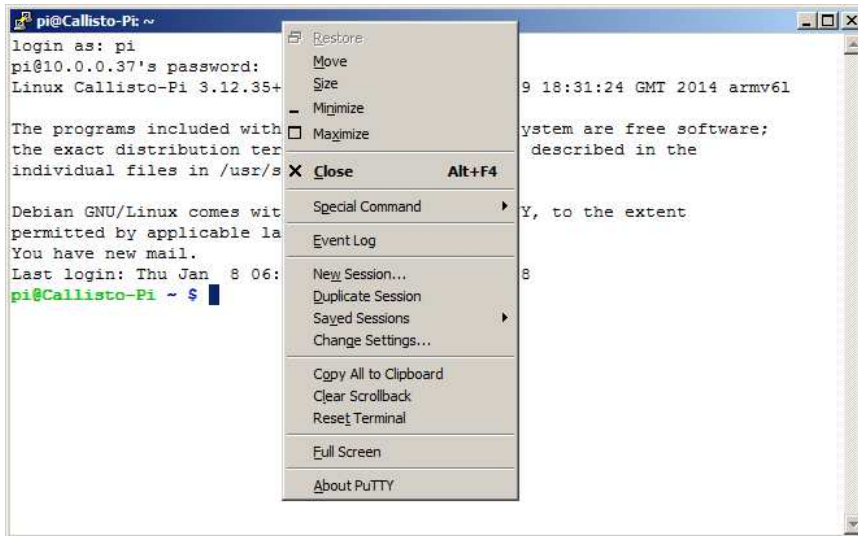
Default username: pi

Default password: raspberry

After logging into RPi, you will see the prompt

```
pi@raspberrypi ~ $
```

At any time you can right-click the bar at the top of the PuTTY window to see the PuTTY menu. Click Change Settings ... if you would like to revise the user interface and session settings.



This operating system and software are modified and provisioned as described in the following sections.

- ⚙ **Text in Blue is typed at the RPi prompt**
- ⚙ **Text in Red indicates editing inside a configuration file**

Initial setup: Several initial setup steps use the built-in nano editor. See the last section for a very brief review of nano commands.

Log into the RPi using PuTTY. First, set the default keyboard layout using the nano editor. Replace the `xkbmodel="pc105"` with `xkbmodel="pc104"` and `xkblayout="gb"` with `xkblayout="us"`:

```

sudo nano /etc/default/keyboard

# KEYBOARD CONFIGURATION FILE
# Consult the keyboard(5) manual page.

XKBMODEL="pc104"
XKBLAYOUT="us"
XKBVARIANT=""
XKBOPTIONS="lv3:ralt_switch,terminate:ctrl_alt_bksp"

BACKSPACE="guess"

```

Type CTRL-X (Exit), Y (yes), Enter to save and close the editor.

Change host name: To change the host name (example, My-Pi), edit the `/etc/hosts` file:

```
sudo nano /etc/hosts
```

Change the name associated with address 127.0.1.1 (do not change 127.0.0.1), as in:

```
127.0.1.1      My-Pi (this is an example, use the desired name for your application)
```

Similarly, replace the name in the `/etc/hostname` file:

```
sudo nano /etc/hostname
```

Change the name from raspberry, as in

My-Pi (this is an example, use the desired hostname for your application)

Type CTRL-X (Exit), Y (yes), Enter to save and close the editor.

After changes have been made to both the hosts and hostname files, commit the changes to the kernel by entering

```
sudo /etc/init.d/hostname.sh
sudo reboot
```

Change password: Log into the RPi using the defaults:

User: pi

Password: raspberry

At the prompt enter the following command:

```
passwd
```

Note: Only change the password for user: pi as instructed above – DO NOT enter `sudo passwd`

RPi responds with:

```
Changing password for pi
(current) UNIX password:
```

Enter the current (default) password. No characters will be displayed. Enter the new password and confirm it when RPi responds with:

```
Enter new UNIX password:
Retype new UNIX password:
```

Enter the new password. After RPi accepts the new password you will see the following. The new password will take effect immediately:

```
passwd: password updated successfully
```

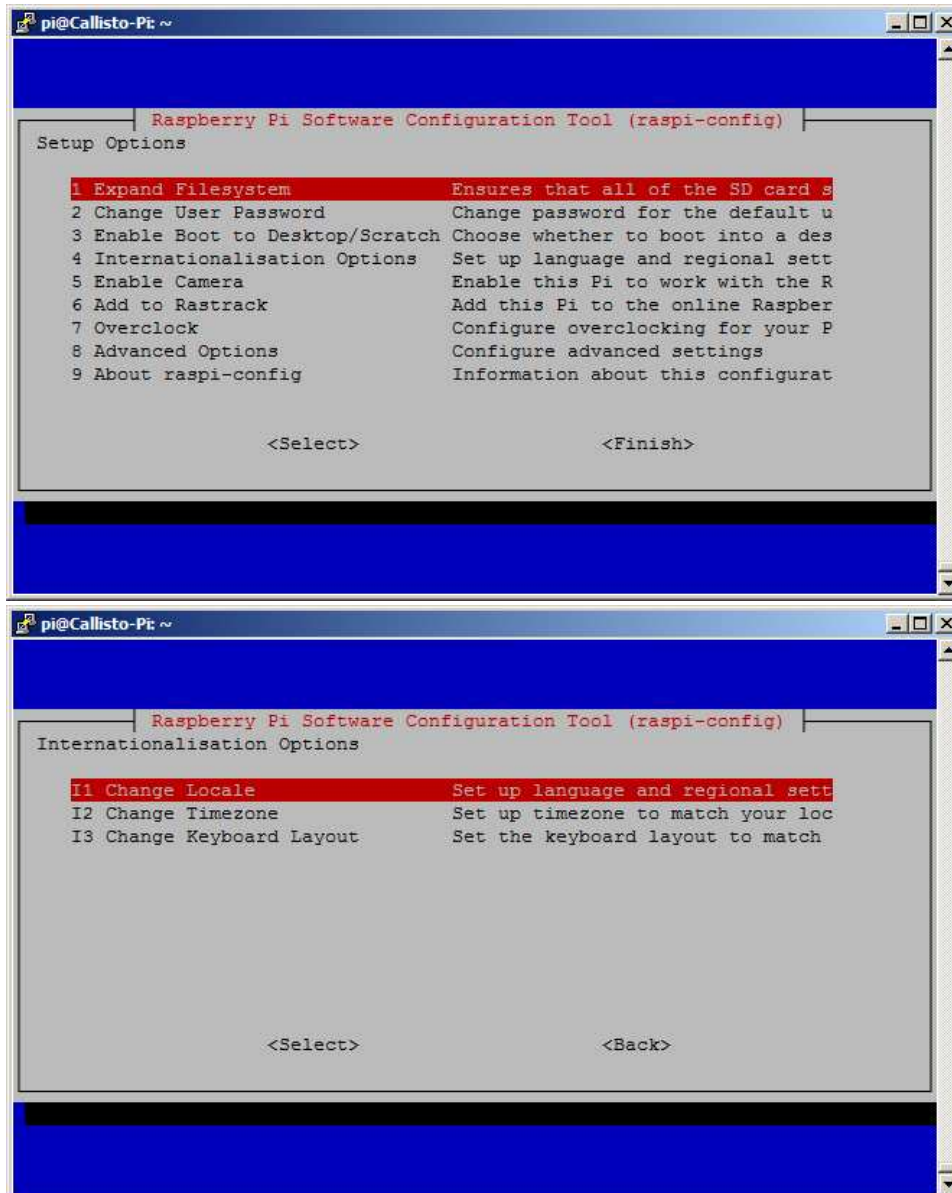
Enter the following command at the prompt. After a moment a window will appear with a list of settings. Use the arrow keys to select the desired option, press Tab to Select and then Enter:

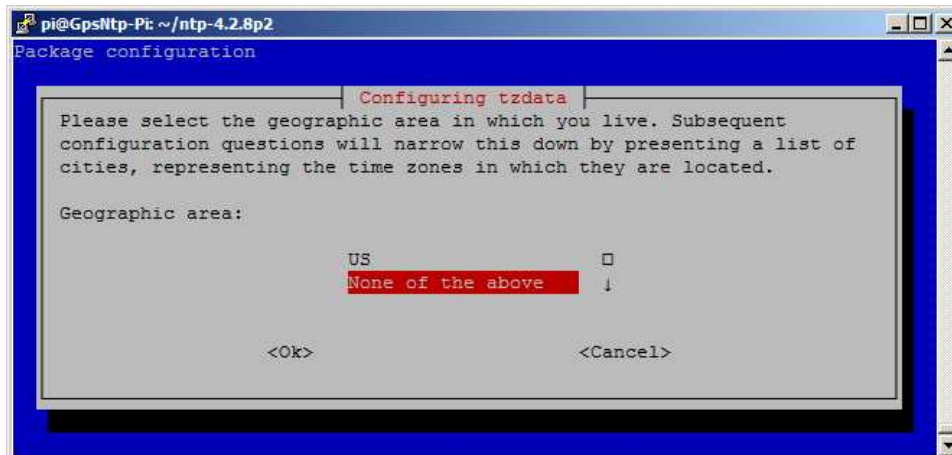
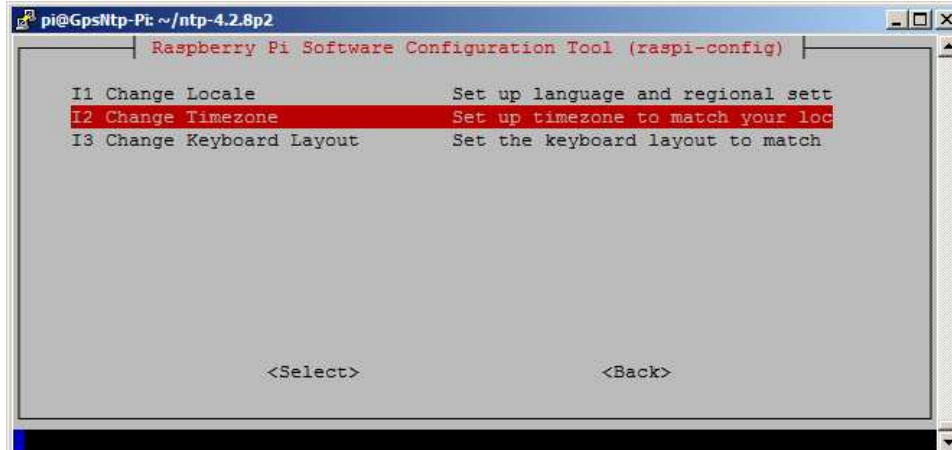
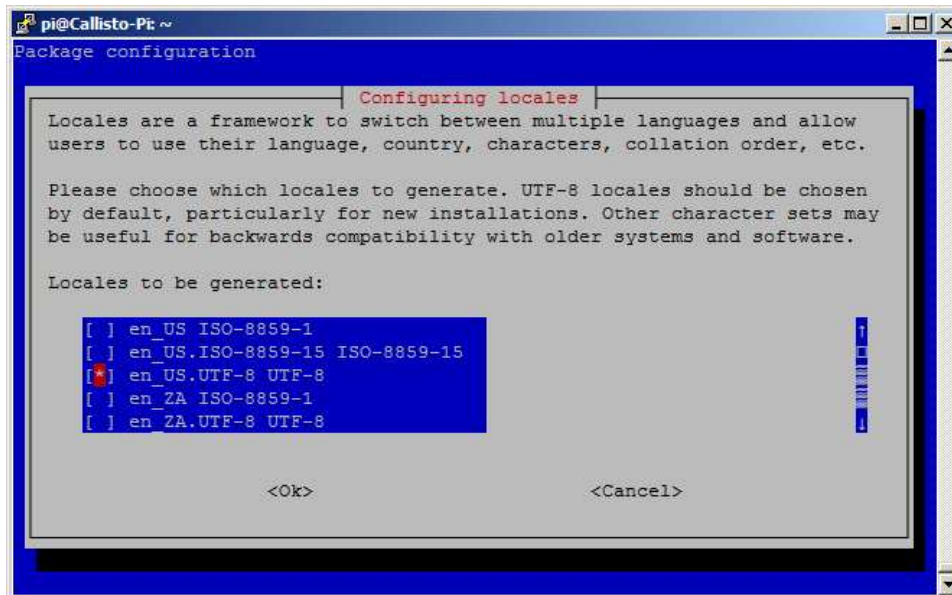
```
sudo raspi-config
```

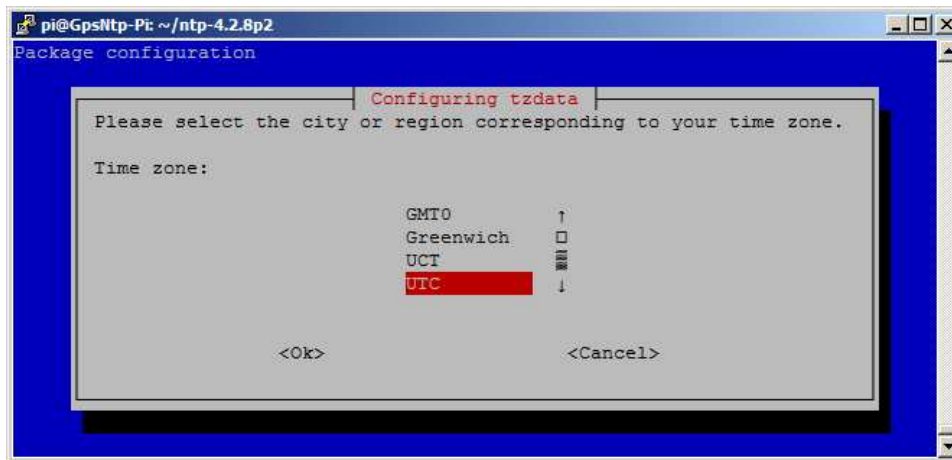
- ⚙ Select Option 9. Advanced Options – A0 Update. This option updates to the latest Raspi-Config tool.
- ⚙ Select Option 1. Expand filesystem
- ⚙ Select Option 5. Internationalization Options – Option I1. Change Locale – en_US.UTF-8 UTF-8. Use the spacebar to deselect en_GB.UTF-8 UTF-8. Scroll down to en_US.UTF-8 UTF-8 and select it with the spacebar. Scroll through the entire list to make sure only one Locale is selected
- ⚙ Select Option 5. Internationalization Options – Option I2. Change Timezone. On Configuring tzdata window, select None of the Above and then UTC. The UTC timezone is required for the NTP server application
- ⚙ Select Option 5. Internationalization Options – Option I3. Change Keyboard Layout

- ⚙ Select Option 9. Advanced Options – A8 Enable or Disable Serial Shell – Accessible – No. This option is required to disable system messages from appearing on the internal serial port (TxD and RxD).
- ⚙ Finish & Reboot

Example screenshots are shown below.







When initial setup is complete:

```
sudo reboot
```

Now it is necessary to update the software and operating system. These steps may require several minutes and the screen may appear to freeze at times but be patient:

```
sudo apt-get update
sudo apt-get dist-upgrade
sudo rpi-update
sudo reboot
```

Timekeeping

The RPi does not have a hardware real-time clock and uses a software clock instead. By default the Raspbian operating system uses the Network Time Protocol for timekeeping. The NTP always uses Coordinated Universal Time (UTC) but the RPi clock itself may be set to any time zone by running `raspi-config` as described above. However, it is recommended that UTC be used for all technical RPi projects.

The Raspbian Stretch version (available September 2017) apparently does not include NTP; therefore, install it using

```
sudo apt-get update && sudo apt-get -y install ntp
```

The default NTP configuration uses a pool of NTP servers as shown immediately below.

```
# pool.ntp.org maps to about 1000 low-stratum NTP servers.  Your server will
# pick a different set every time it starts up.  Please consider joining the
# pool: <http://www.pool.ntp.org/join.html>
server 0.debian.pool.ntp.org iburst
server 1.debian.pool.ntp.org iburst
server 2.debian.pool.ntp.org iburst
server 3.debian.pool.ntp.org iburst
```

For many projects there is no reason to change the server list but for projects that rely on the RPi clock for data time-stamping, the default pool should be refined to use time servers based in the country or region where the RPi is to be located. A list of server pools may be found at [{NTPPool}](#). To edit the NTP configuration file:

```
sudo nano /etc/ntp.conf
```

For the United States, replace the four servers listed above with

```
server 0.us.pool.ntp.org iburst
server 1.us.pool.ntp.org iburst
server 2.us.pool.ntp.org iburst
server 3.us.pool.ntp.org iburst
```

Type CTRL-X (Exit), Y (yes), Enter to save and close the editor. Now, restart the NTP service:

```
sudo service ntp restart
```

To query NTP

```
ntpq -crv -p
```

Backup and Restore

Backup your RPi software images after provisioning. See [{BkRsRPi}](#) for procedures.

Software Manuals

Each software function in the RPi software has a “manual”, which can be accessed by typing at the prompt `man` followed by the function name. For example, to read the manual for the NTP daemon, type `man ntpd` and for the GPS daemon, type `man gpsd`.

Some Useful Software Tools

To monitor CPU and memory load, use the `top` command or install a similar tool called `htop`. To use `top`, enter

```
top
```

To install `htop`, enter

```
sudo apt-get install htop
```

and to use it, enter

```
htop
```

Exit both `top` and `htop` with CTRL-C.

To determine the CPU temperature enter

```
vcgencmd measure_temp
```

or

```
/opt/vc/vcgencmd measure_temp
```

To determine the usage on the micro-SD or SD memory card, use the disk filesystem command

```
df -h
```

To reduce space used by archived logs, first use WinSCP to check the following directory for archived log files (*.gz)

```
/var/log/
```

If archived files exist and you do not want them, go to a PuTTY (or console) command prompt and enter

```
cd /var/log/
```

```
ls
```

```
sudo rm *.gz
```

The above commands change the directory, list the files and then remove (delete) all files with the `.gz` extension.

To determine the operating system version, go to a PuTTY (or console) command prompt and enter

```
cat /etc/os-release
```

To see details of the wireless and Ethernet LAN interfaces, go to a PuTTY (or console) command prompt and enter

```
iwconfig
```

```
ifconfig
```

Nano Editor

Use arrow keys to move the cursor. Move cursor to beginning of text to be copied or cut.

To select text, ALT-a and then use arrow keys

To copy selected text, ALT-^

To cut selected text, CTRL-k

To paste selected text, CTRL-u

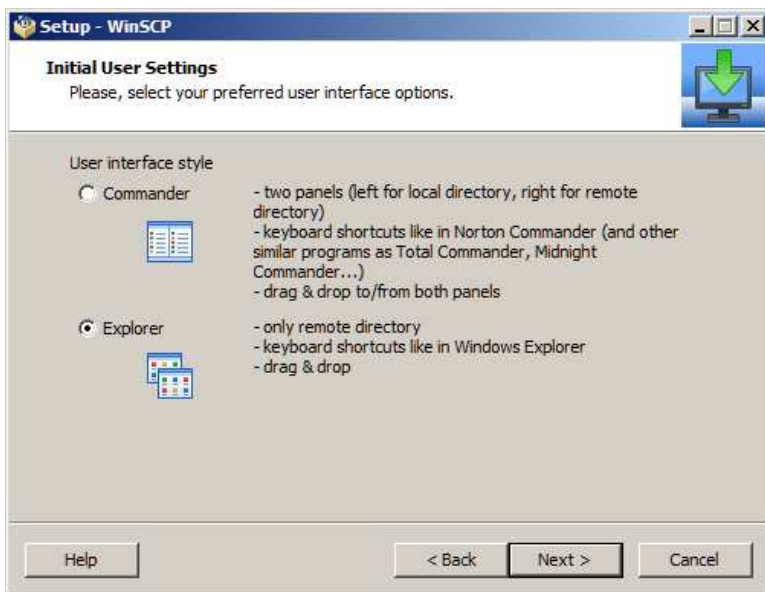
To copy text from a program on the Windows PC and paste it to the PuTTY command line interface, select the text and copy to the Clipboard in the normal way (CTRL-c). To paste the text into the PuTTY prompt, click on the PuTTY window, move the mouse cursor to the PuTTY prompt and right-click the mouse button.

To copy text from the PuTTY command line interface and paste to a program on the Windows PC, place the mouse at the beginning of the text to be copied, left-click and drag to select the text in the normal way. When the left mouse button is released, the text is automatically copied to the Windows Clipboard. It then may be pasted to the Windows PC program in the normal way (CTRL-v).

WinSCP

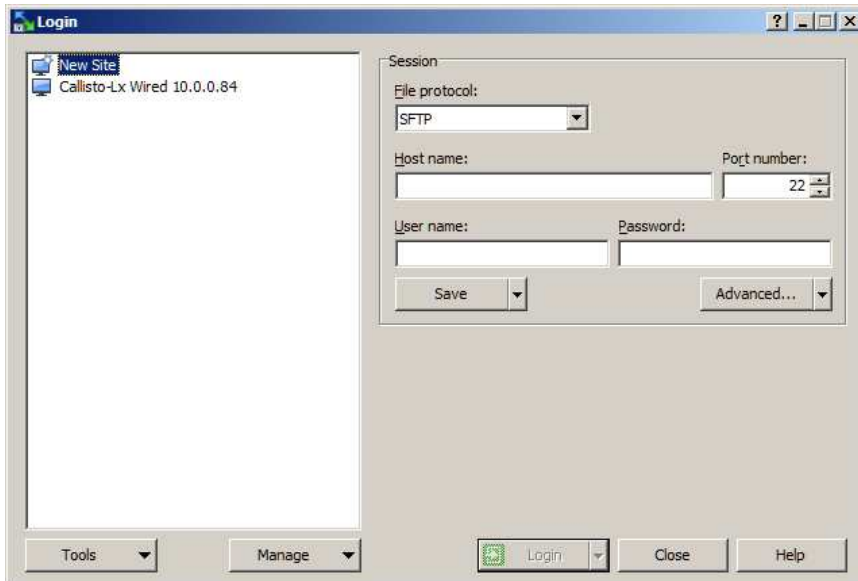
WinSCP is a very useful program (SCP is Secure Copy Protocol) when operating and setting up the RPi from a Windows PC. It is similar to Windows file explorer and can be downloaded from <https://winscp.net/eng/download.php>. With WinSCP, the RPi files can be dragged/dropped to and from a Windows environment, something not easily done with the RPi console.

After download, install WinSCP in the normal way; choose "Typical Installation" (default) and then when the Initial User Settings window appears, select the "Explorer" User interface style (not the default), see below.



If you already have PuTTY installed on the PC, WinSCP will ask if the sites in PuTTY should be imported; select Yes to simplify later use. The next window displayed during installation will list the sites and some can be unselected if desired. When the installation finishes, the last window allows WinSCP to be launched, or it can be launched the normal way from Windows.

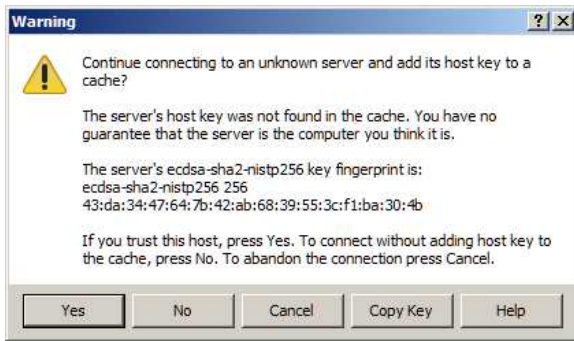
When WinSCP is first launched, a Login window will open that allows a new or existing site to be selected, see example below that shows the New Site selected and an existing site imported from PuTTY in the left pane.



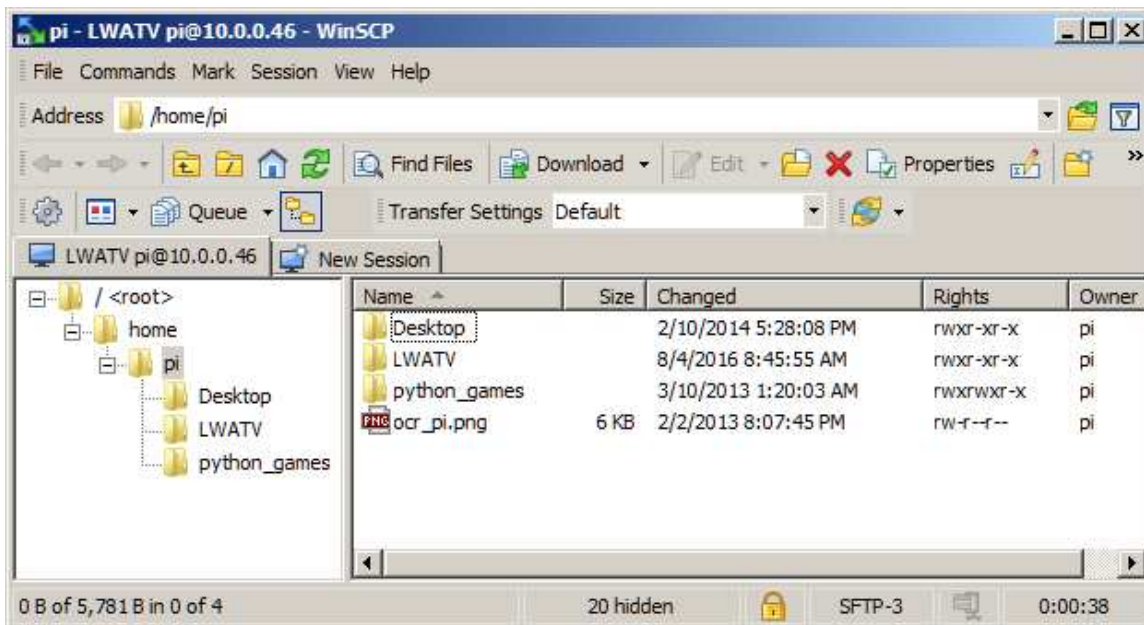
For a new site, enter the hostname or IP address in the “Host name” field in the right frame. Below that enter the associated User name and Password and click the Login button.



A Warning window will popup. Click Yes.



Next, the main WinSCP window will open (see below). The left pane will show the entire RPi directory structure (it may be necessary to double-click /<root> a couple times). Any directory can be opened in the right pane by double-clicking the directory, and files can be dragged and dropped from a Windows folder on the PC (such as My Computer or any File Explorer window) to the selected location on the RPi. To edit a file in WinSCP, right-click it and select **Edit** from the list, or simply double-click the file.



IPV6

IPV6 is implemented in the Raspberry Pi but is not supported by most home routers yet the RPi continuously attempts to obtain an ipv6 address using DHCP. To disable, edit the ipv6 configuration file:

```
sudo nano /etc/modprobe.d/ipv6.conf
```

Add the following

```
# Uncomment following to disable ipv6
# Check with lsmod and ifconfig
alias ipv6 off
options ipv6 disable_ipv6=1
blacklist ipv6
```

Type CTRL-X (Exit), Y (yes), Enter to save and close the editor. Reboot the RPi:

```
sudo reboot
```

Check that ipv6 does not appear in `lsmod` and `ifconfig`

Web Links and References

- {AdvancedIP} <http://www.advanced-ip-scanner.com/>
- {AngryIP} <http://angryip.org/>
- {BkRsRPi} http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_BackupRestore.pdf
- {Etcher} <https://etcher.io/>
- {HDDRaw} <http://hddguru.com/>
- {Netscan} <https://www.softperfect.com/products/networkscanner/>
- {NTPPool} <http://www.pool.ntp.org/en/use.html>
- {PuTTY} <http://www.putty.org/>
- {Raspbian} <http://www.raspberrypi.org/downloads/>
- {SDForm} https://www.sdcard.org/downloads/formatter_4/index.html
- {WDImg} <http://sourceforge.net/projects/win32diskimager/>

Document information

Author: Whitham D. Reeve

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0.1 (Updates and added nano editor, 01 Mar 2015)

0.2 (Added IP scanner, 26 Apr 2015)

1.0 (Initial distribution, 29 Apr 2015)

1.1 (Minor edits, 21 Jun 2015)

1.2 (Added timekeeping section, 20 Dec 2015)

1.3 (New Raspi-Config, 03 Jan 2016)

1.4 (Added WinSCP, 04 Aug 2016)

1.5 (Added requirement for ssh file, 18 Feb 2017)

1.6 (Clarified hosts and hostname, 03 Mar 2017)

1.7 (Added SD Formatter, 14 Mar 2017)

1.8 (Memory card slot types, 02 Apr 2017)

1.9 (Updated hosts/hostname instructions, 02 Jul 2017)

2.0 (Added top, htop and measure temp, 22 Jul 2017)

2.1 (Added note about password and added NTP for Raspbian Stretch, 12 Sep 2017)

2.2 (Added file management, 19 Nov 2017)

2.3 (Added copy/paste to/from PuTTY and Windows, 29 Jan 2018)

2.4 (Added disable ipv6, 07 Feb 2018)

2.5 (Added OS query and a couple other tools, 12 Nov 2018)