MainsailOS Flashing Guide

> This method is cross-platform and works with Windows, Linux and MacOS
> Raspberry Pi Imager appearance may vary depending on the host OS.

> We **strongly** recommend you use a premium SD card from a reputable manufacturer such as Sandisk, Kingston or Samsung, using an "A1" (or better) grade SD card.
>
> Low end cards will often fail quickly when used in this application.

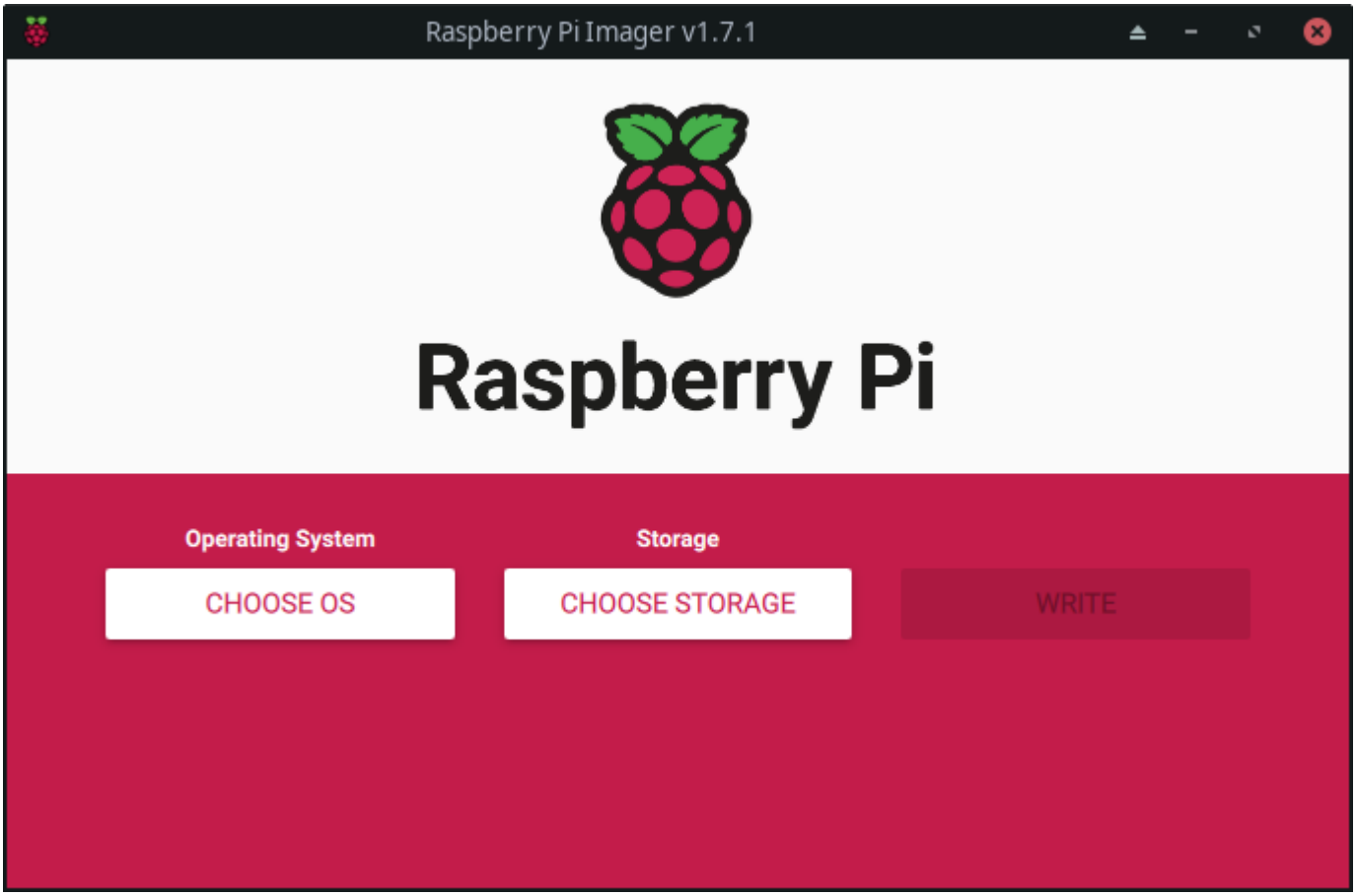
> **FLASHING WILL DESTROY ALL DATA ON YOUR SD CARD AND CANNOT BE REVERSED**

Preparation

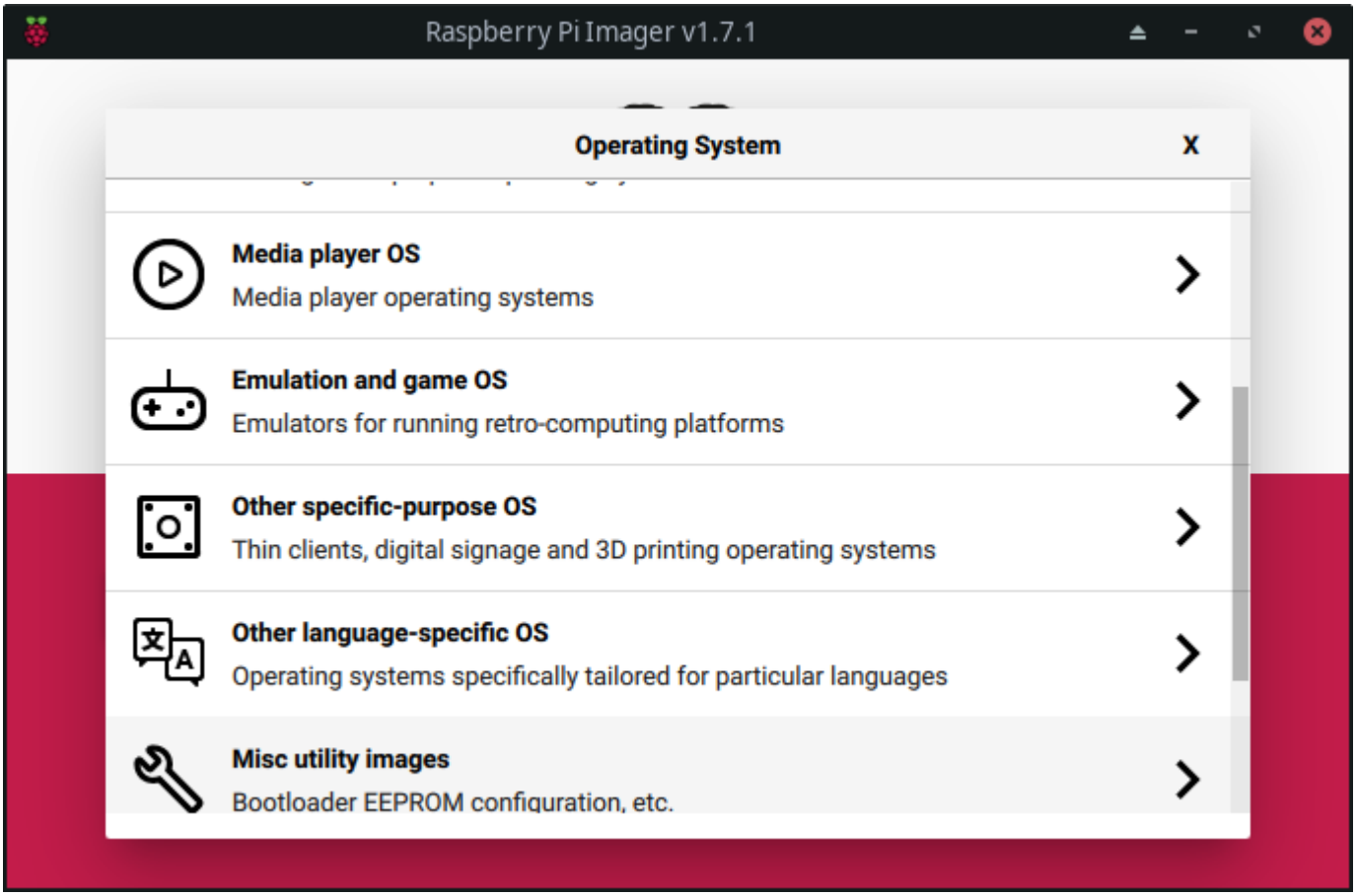
- Download and install the latest Raspberry Pi Imager (v1.7.1).

Flashing MainsailOS

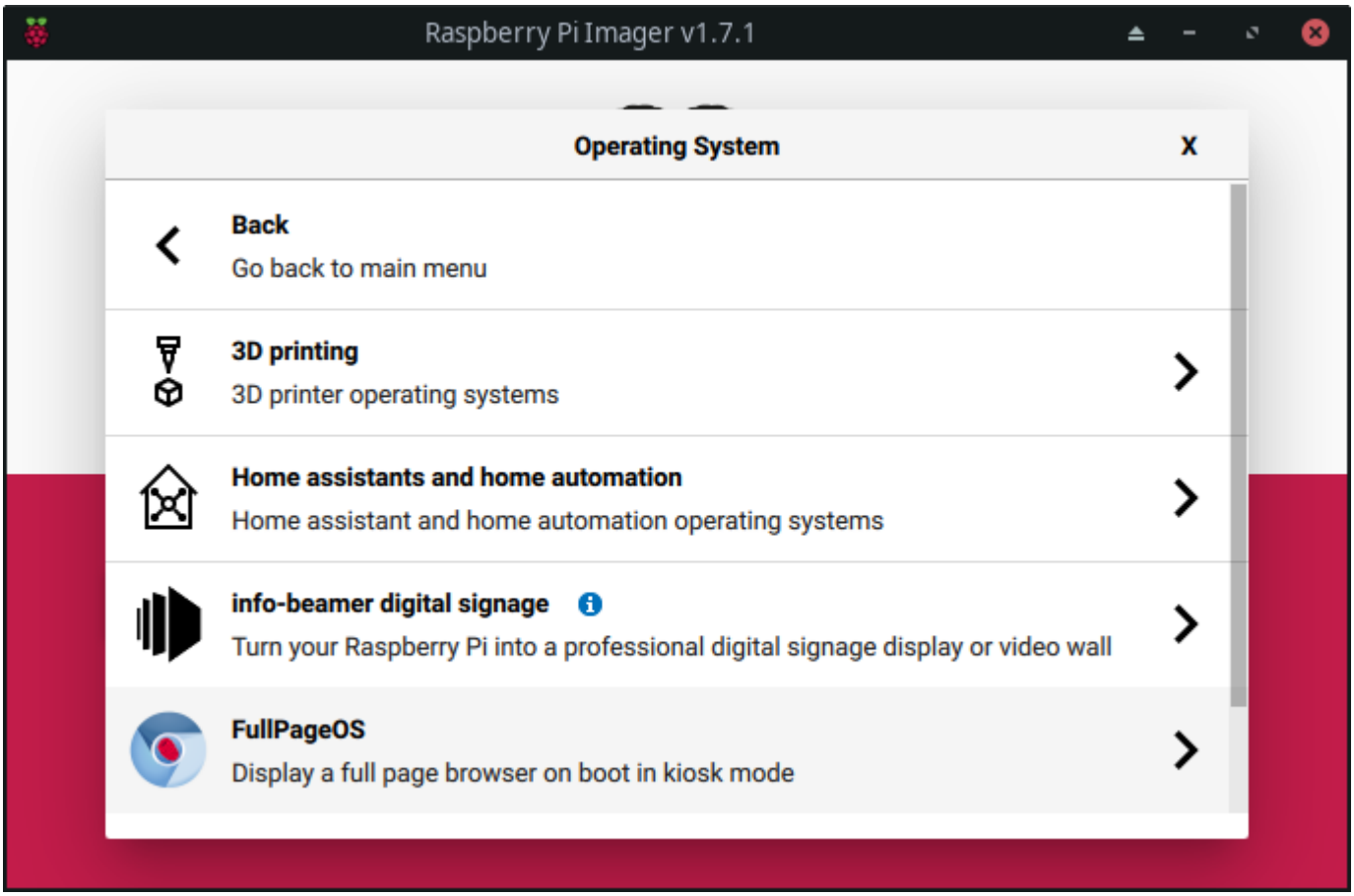
- When opening Raspberry Pi Imager you will be presented with the following:



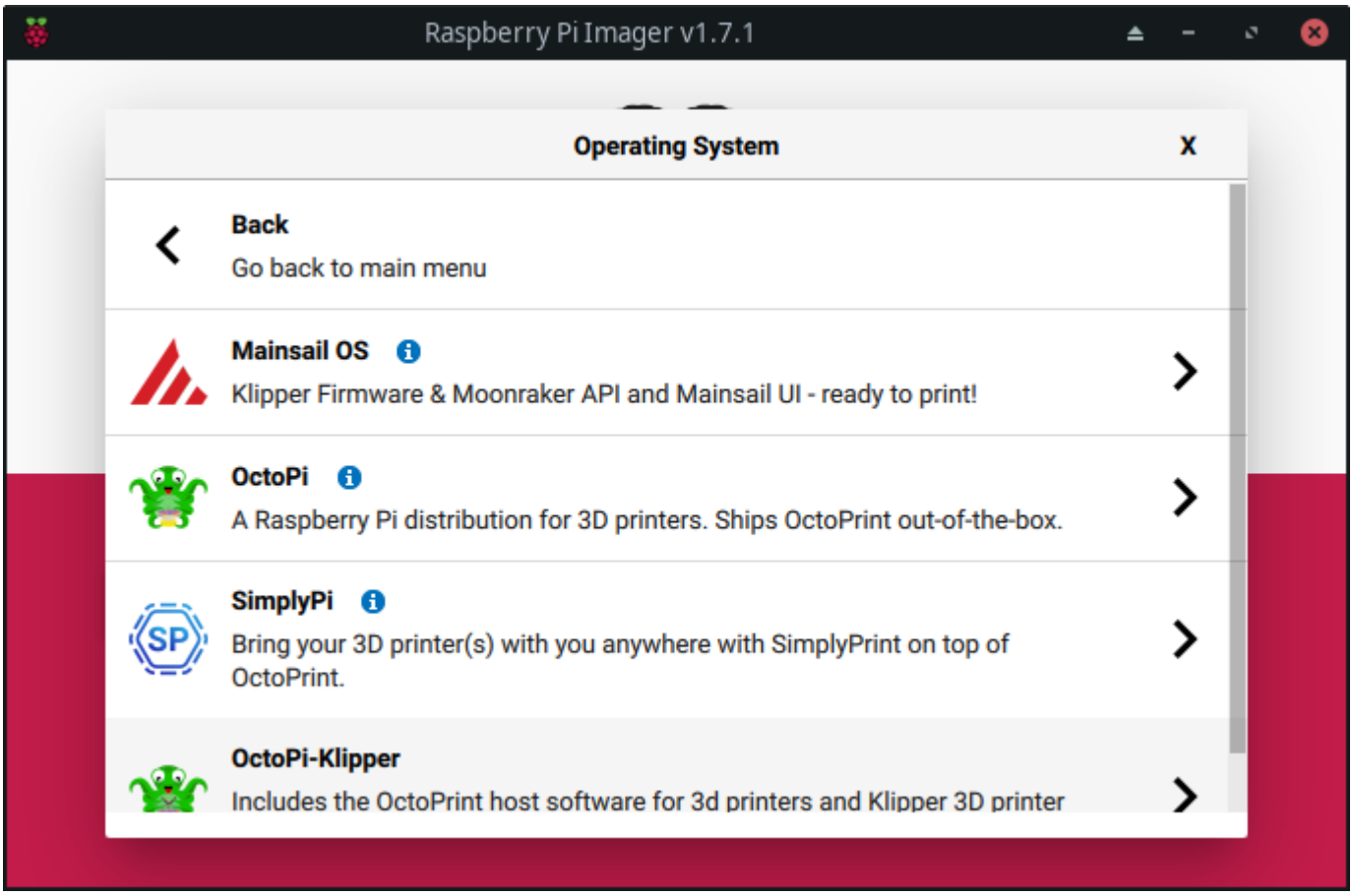
- Select “CHOOSE OS”, and a pop-up will open as illustrated below.
- Scroll down to “Other specific-purpose OS”

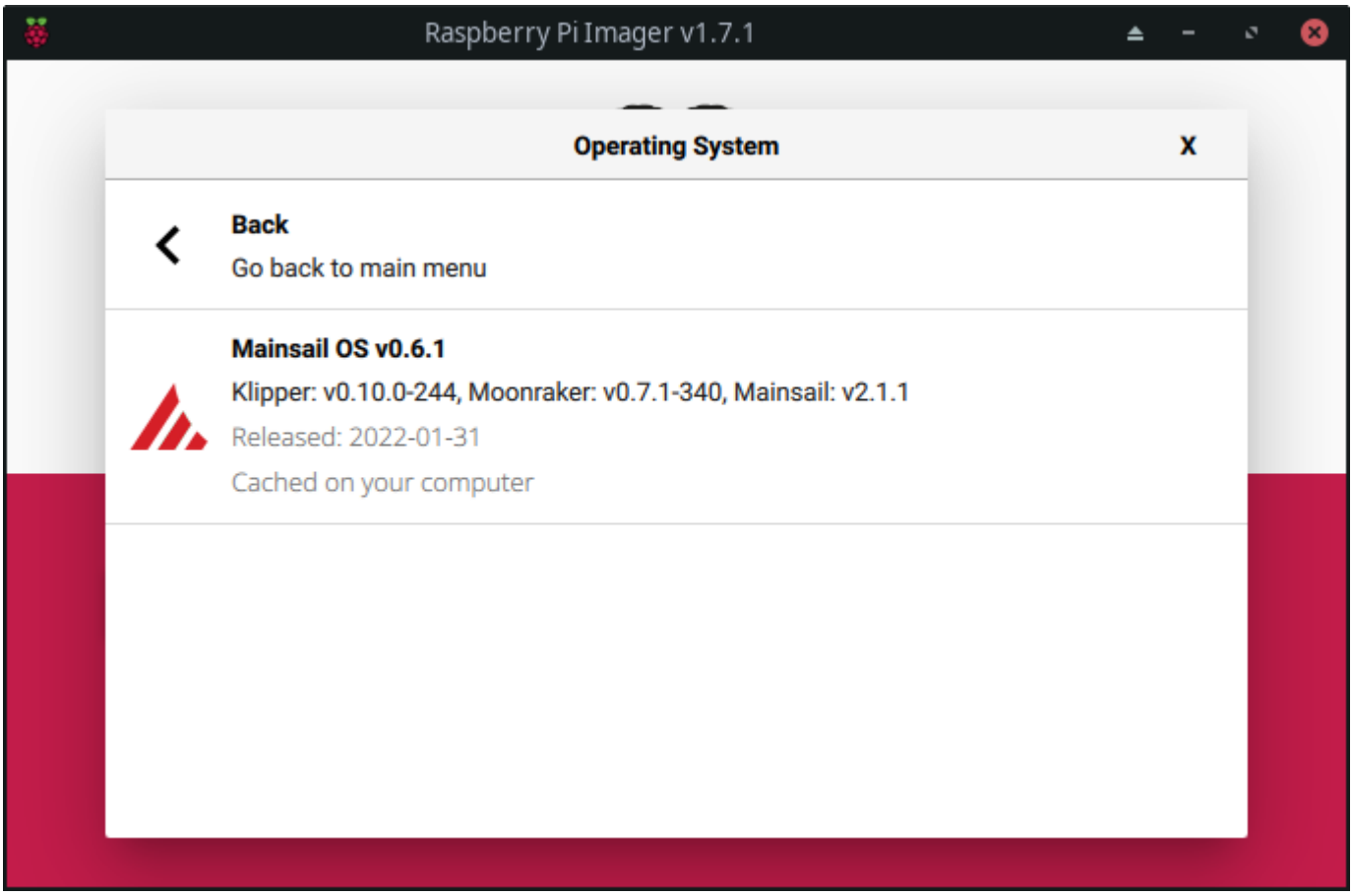


- Select “3D printing”

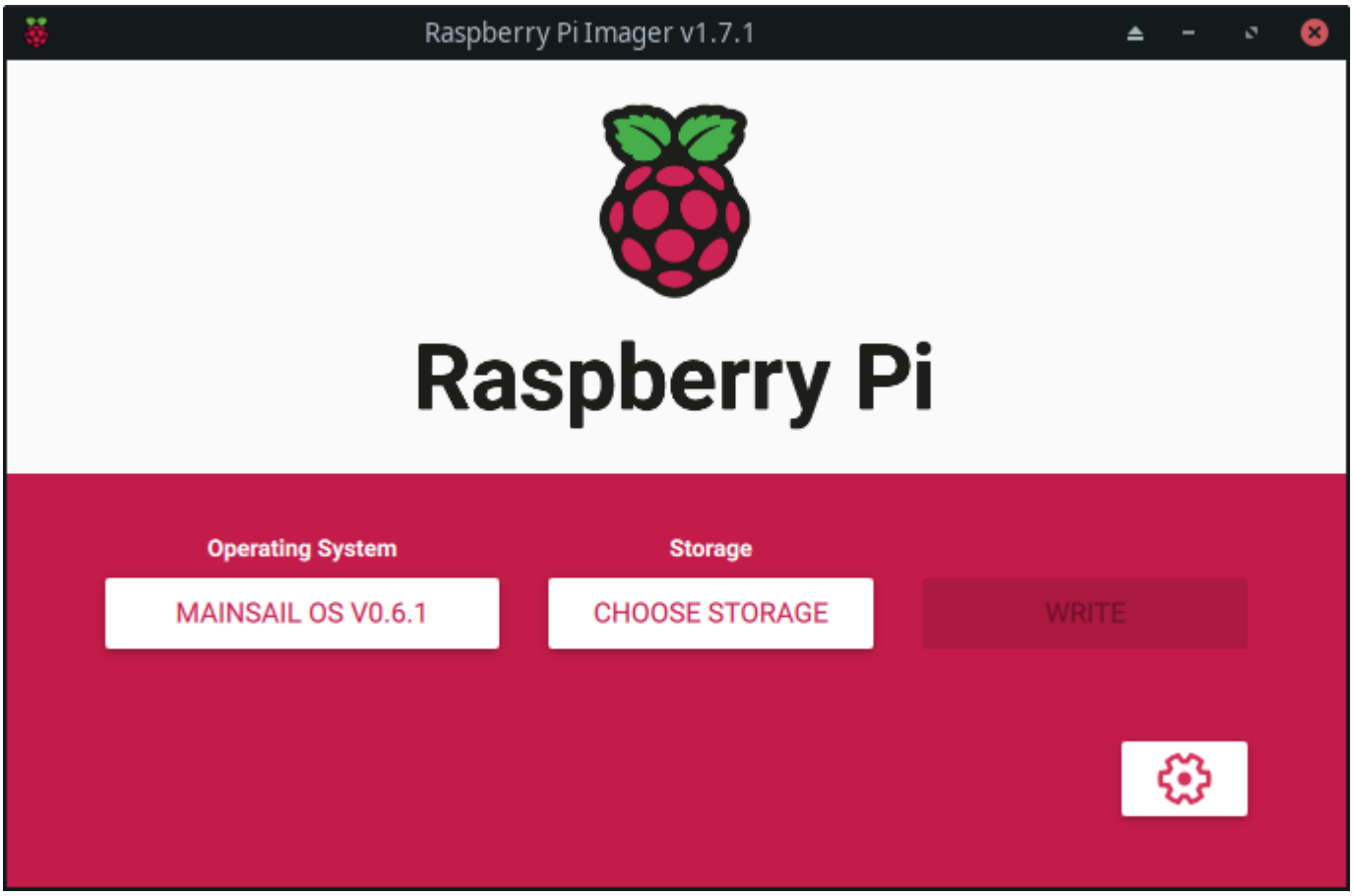


- Choose your prefered 3D printing OS (Mainsail for sure)

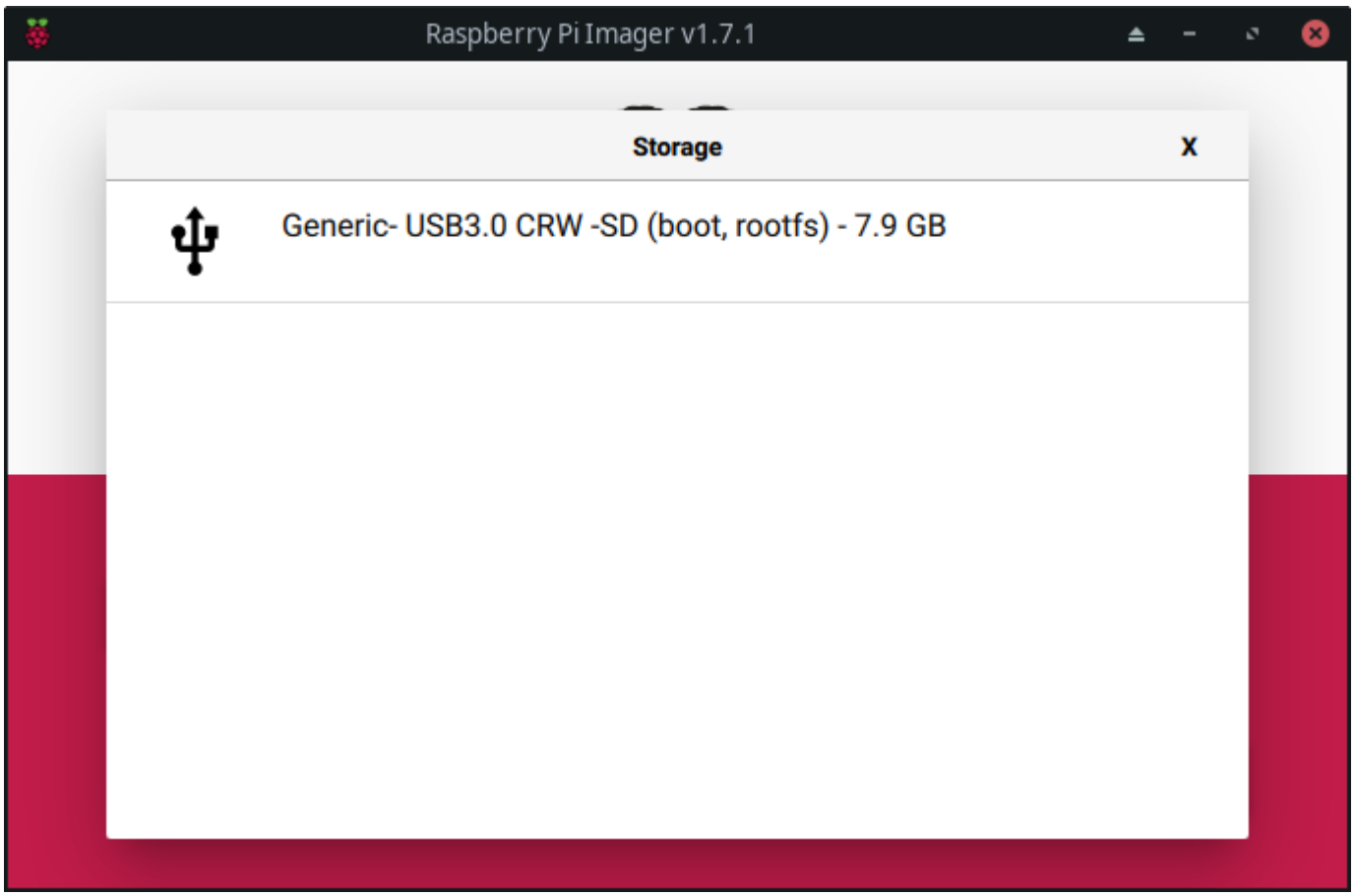


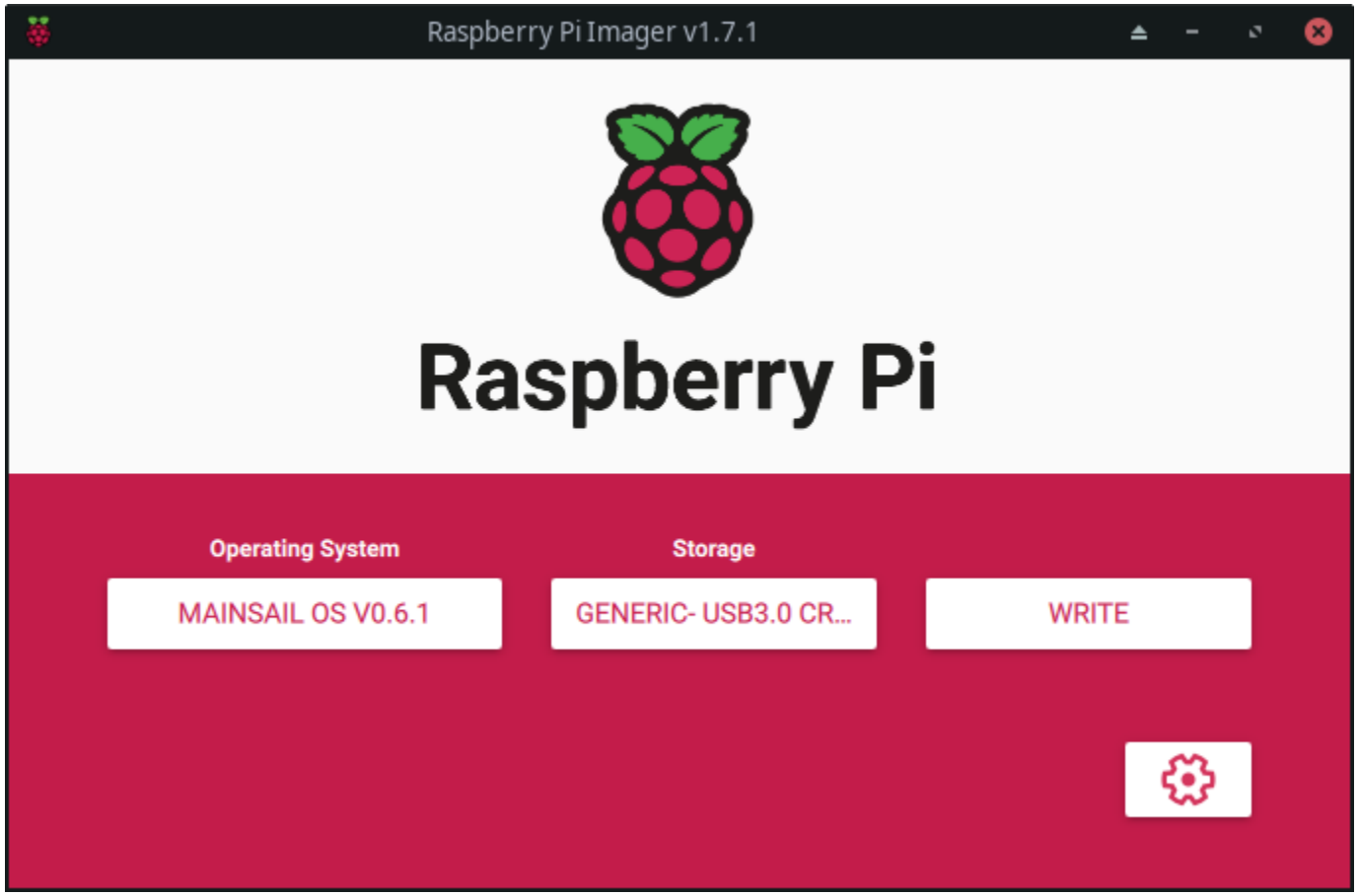


- After that is done click “STORAGE” and select your desired SD card.

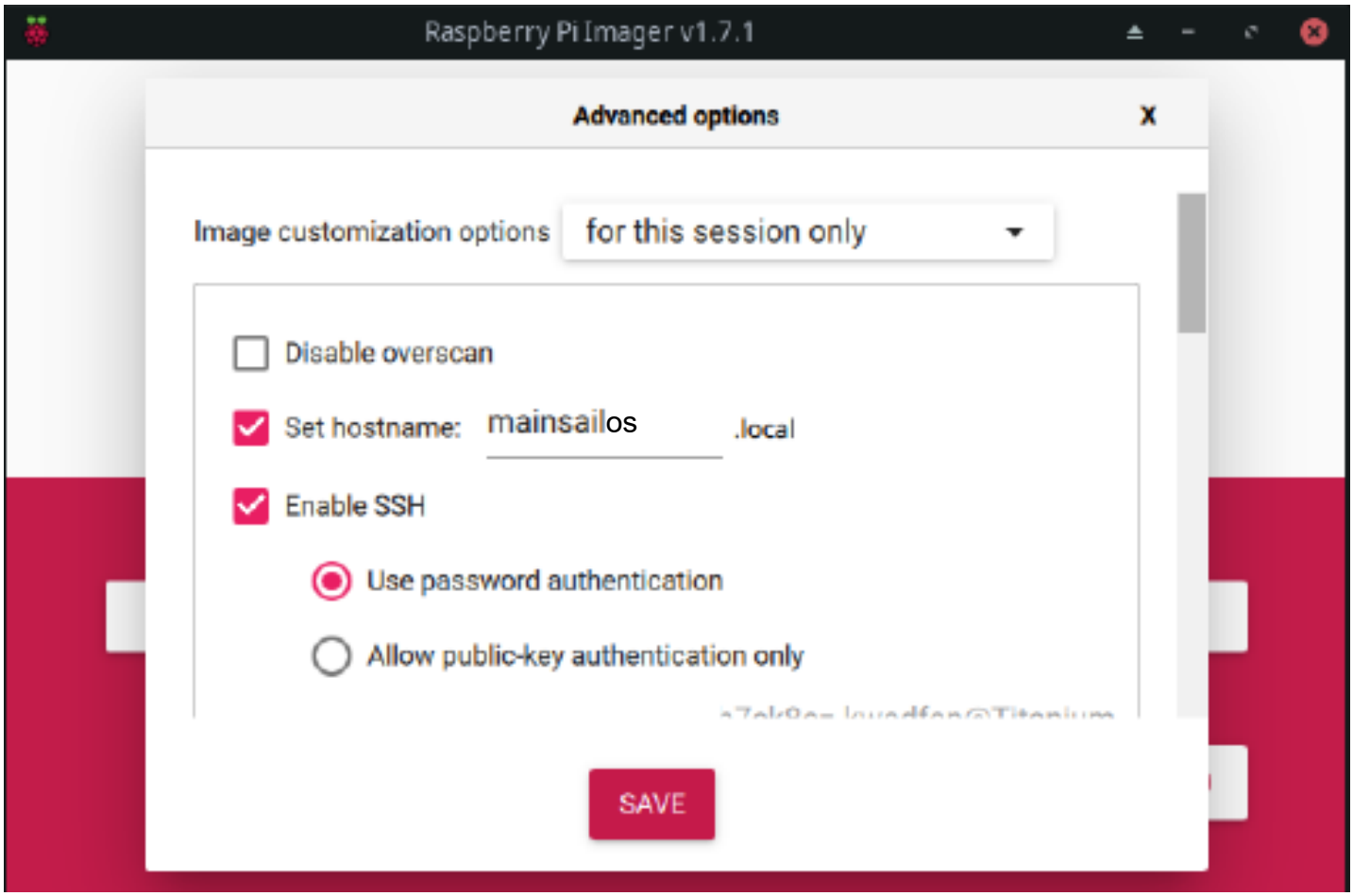


- For example:





- Hostname, Wi-Fi, language and numerous other settings can now be scrolled through and preconfigured in a setup menu, opened by clicking on the little cogwheel in the right corner.



- Optional: Setup your preferred hostname: mainsailos.local will be used in the examples

> If you change the hostname, the URL will be changed accordingly.
> As shown in the screenshot below your URL will be ***http://mainsailos.local***

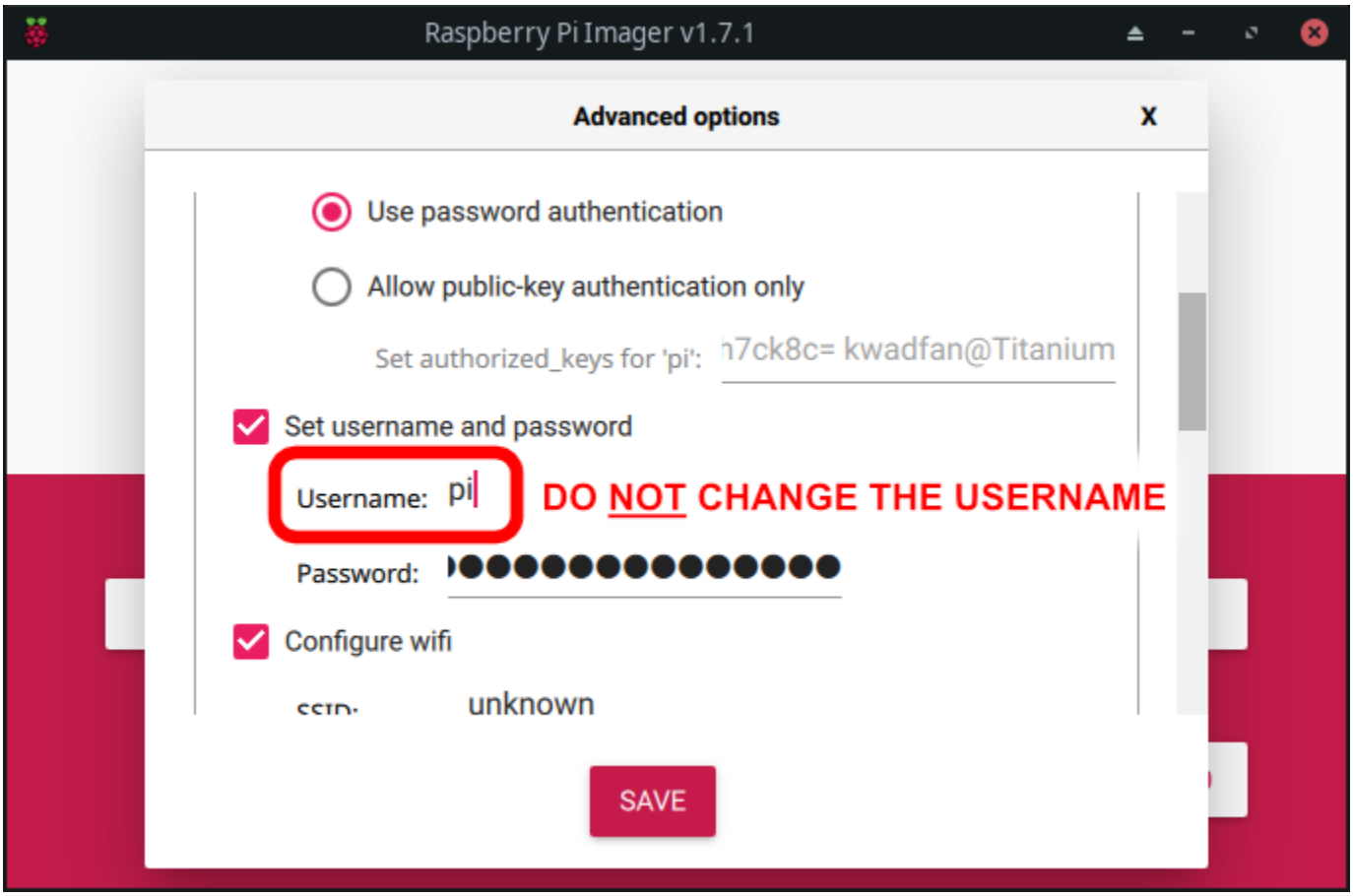
- Change your password, this step is highly recommended!

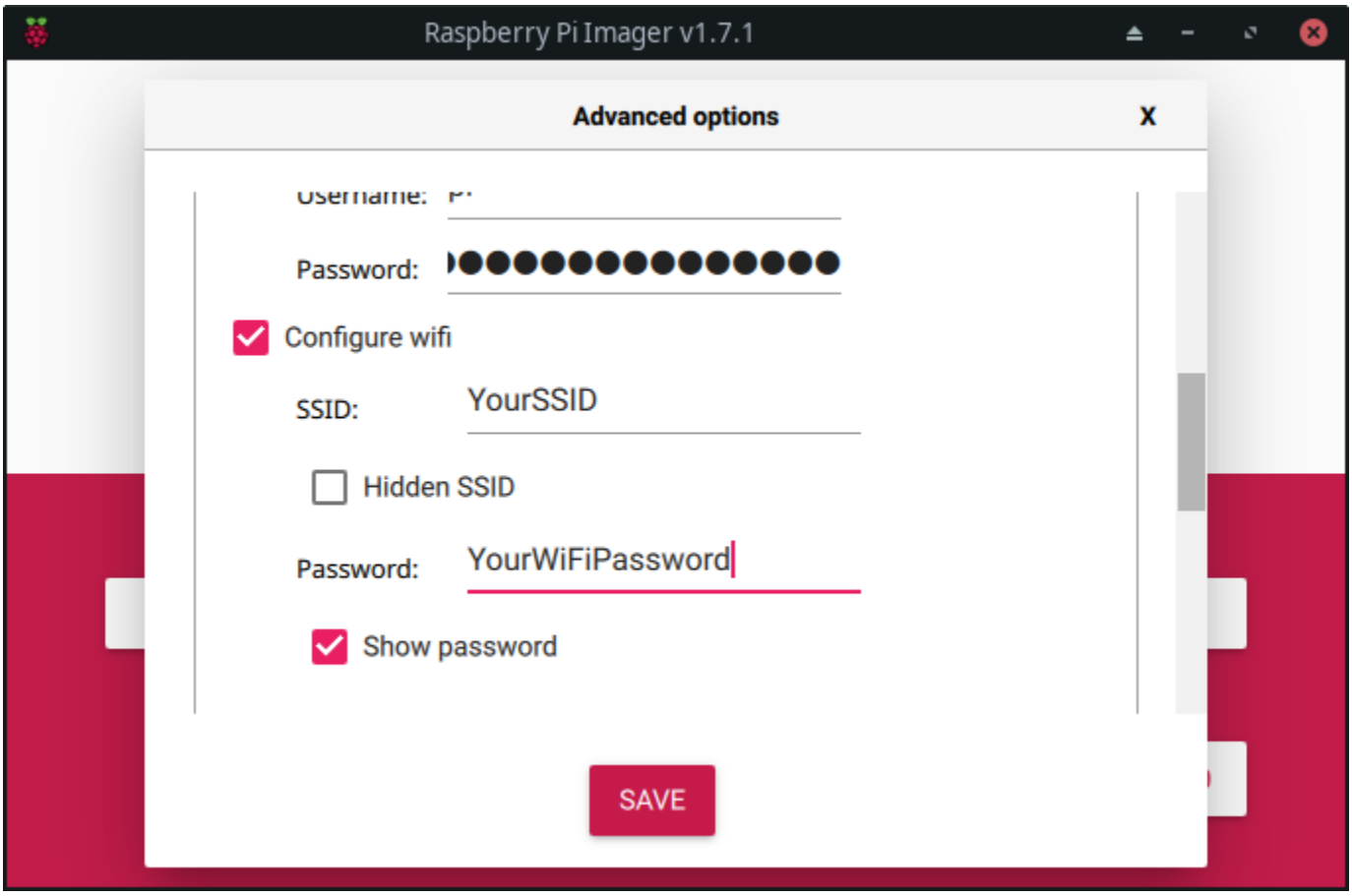
> Please enable SSH! Otherwise, you were'nt able to connect via SSH.

Please don’t change the username!

At this stage MainsailOS Setup relies on the user “pi”.

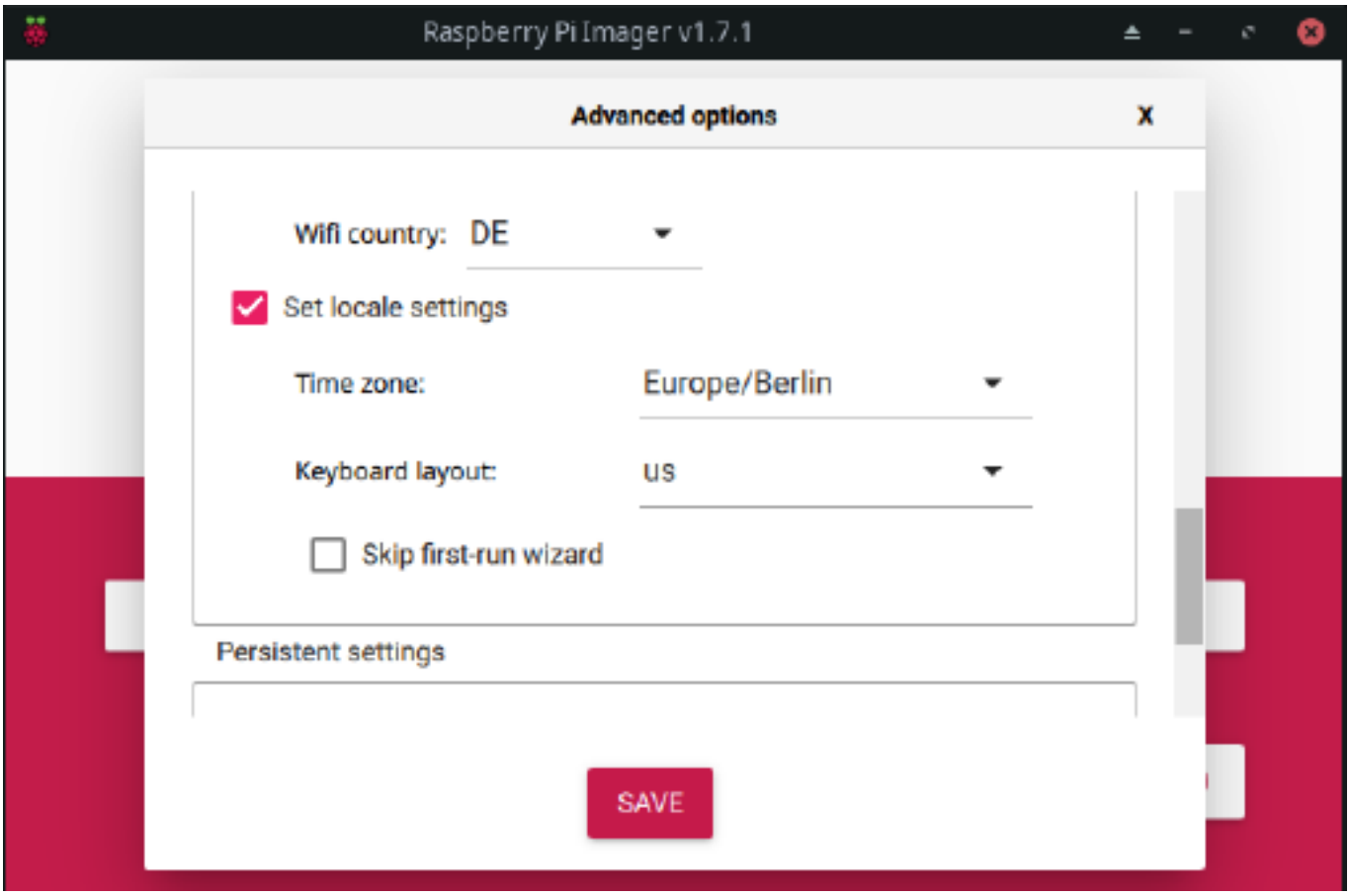
We will change that in the future.



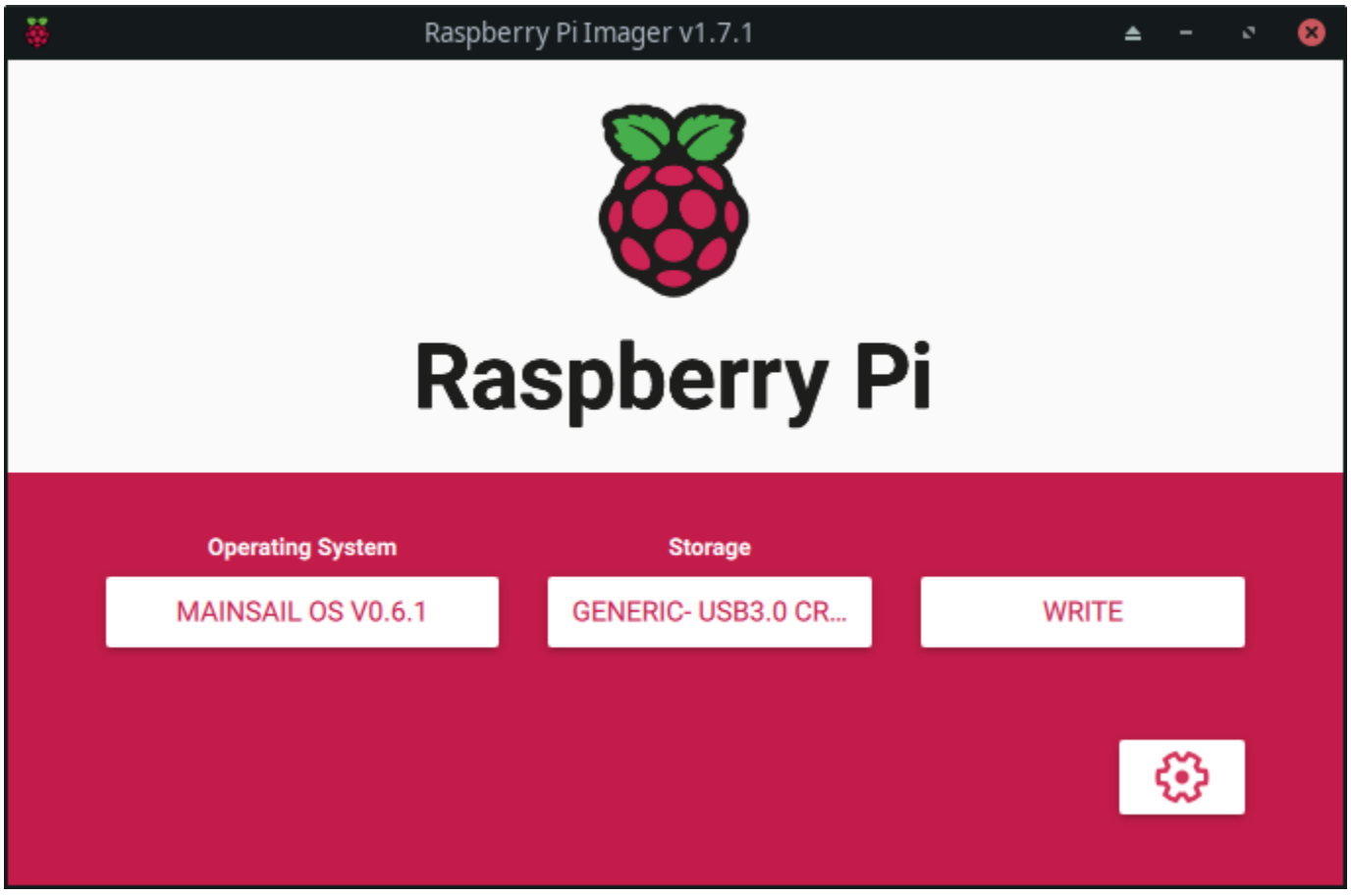


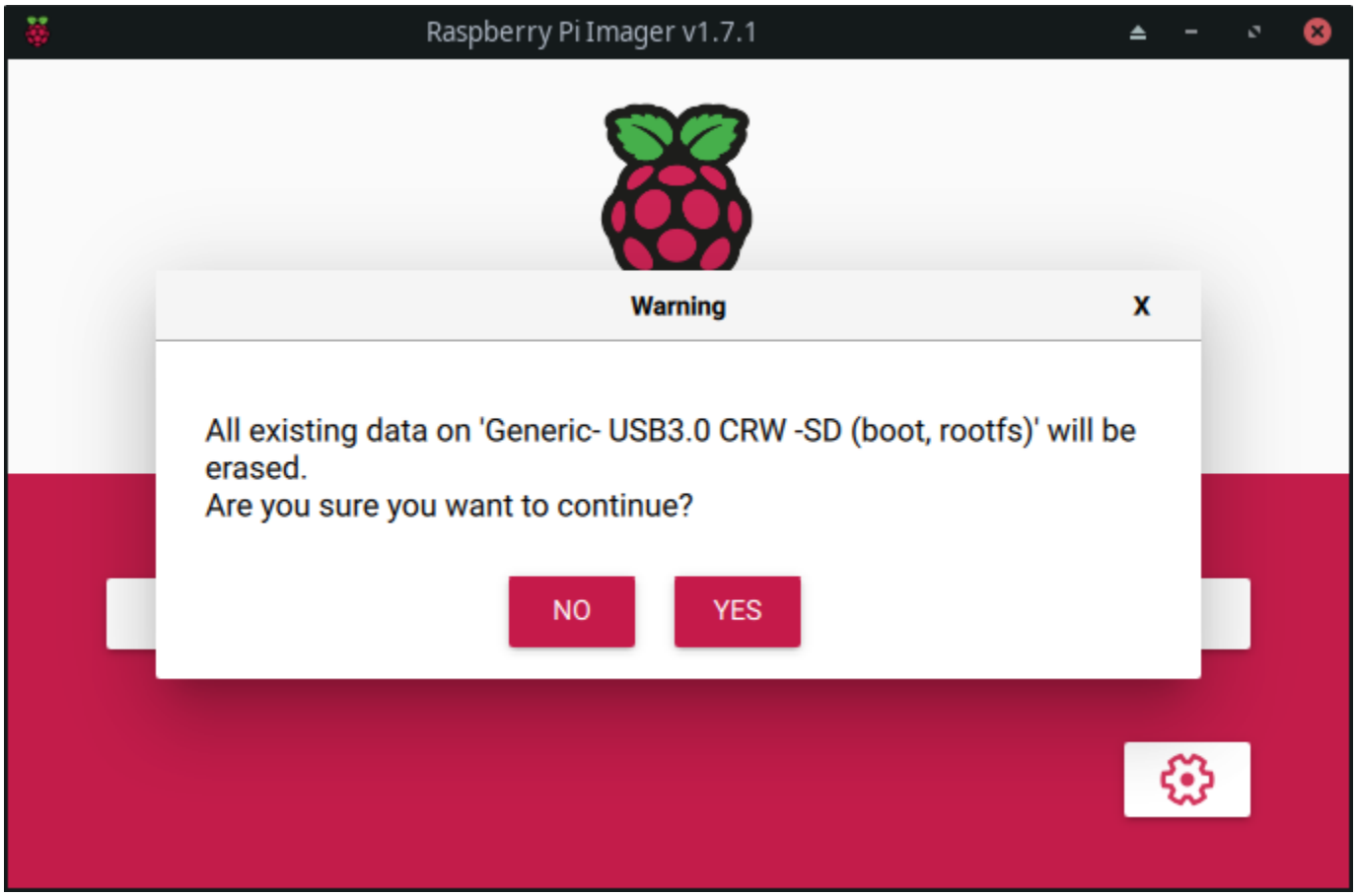
- If you want to use WiFi instead a wired connection, please configure your WiFi accordingly.

- The last step manages your Timezone and Keyboard Layout (Keyboard Layout may affect your language in some cases)



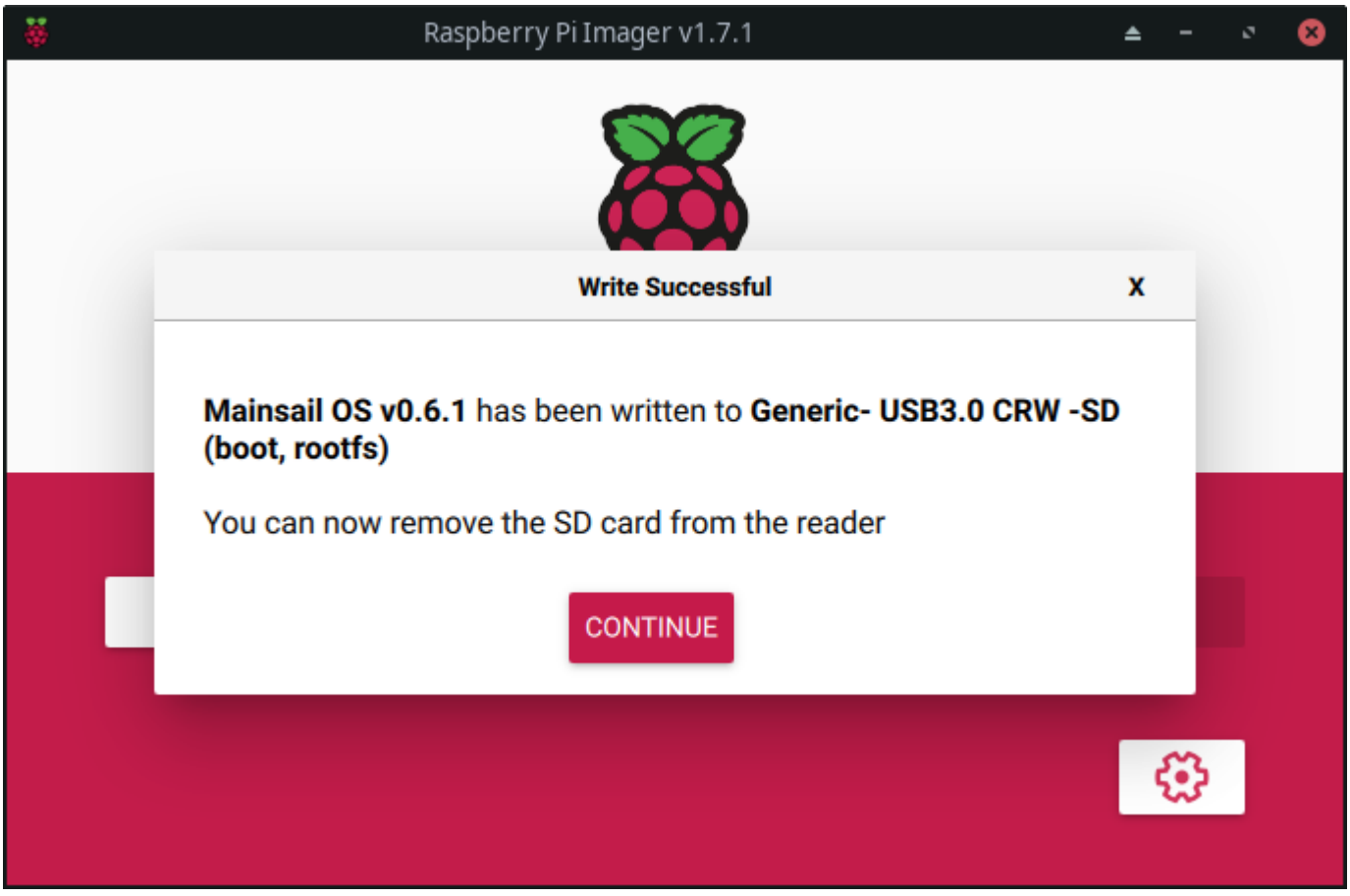
- With all desired options preconfigured, click on “WRITE” and accept the warning.



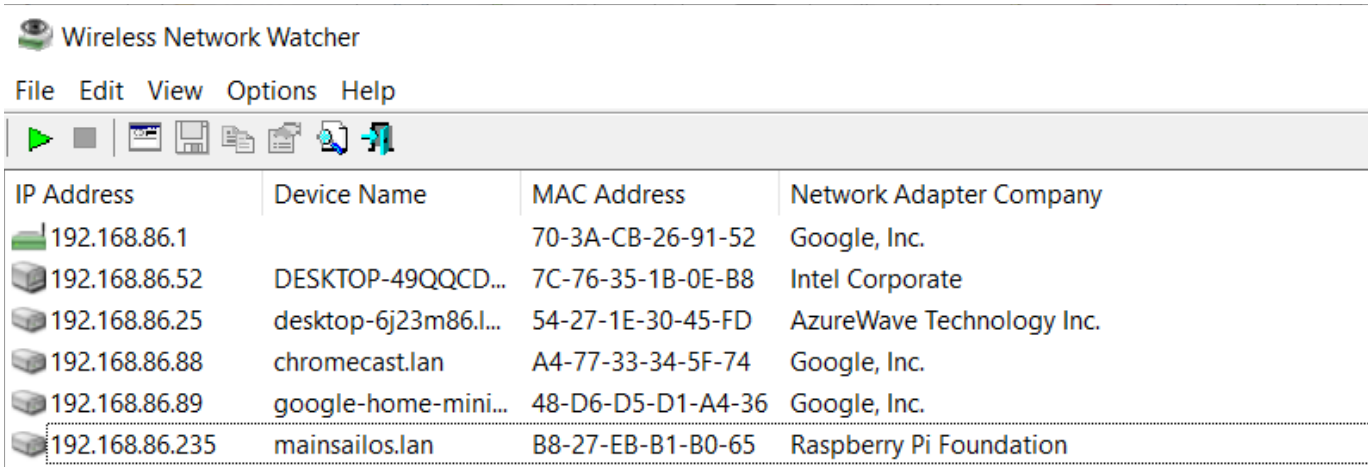


- Imager will take some time to write the image to the SD card.
  When it finished the transfer to your SD Card, it will verify your Image.

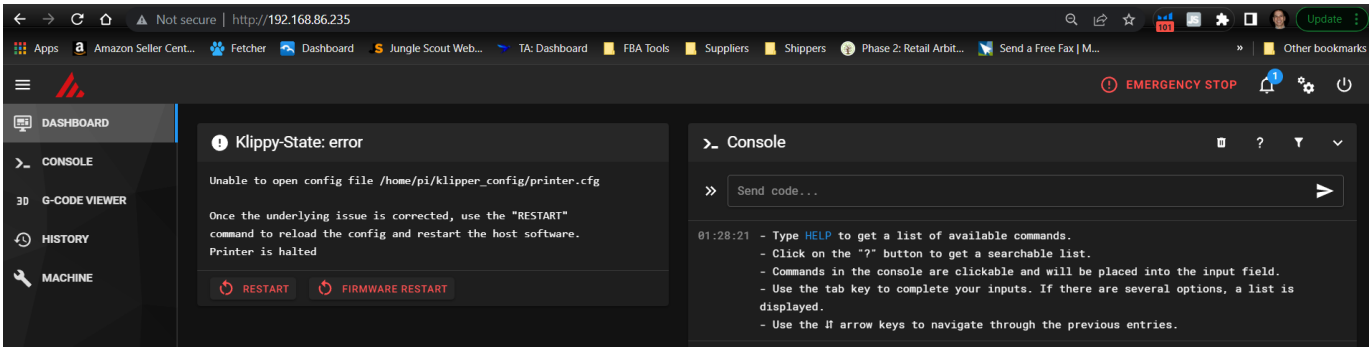
- The Imager will take some time to write the disc image to the SD card. When it's finished, click continue.



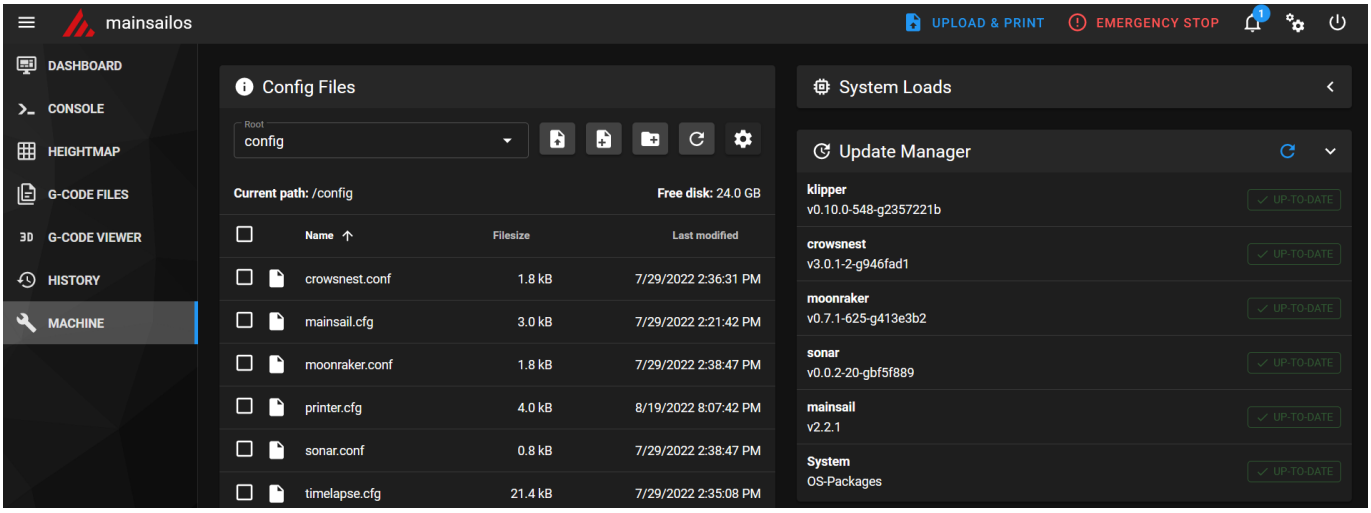
You are now ready to move on to the first boot of MainsailOS. Place the SD card into the Raspberry Pi and plug it in. The first boot will take a few minutes as it builds the file structure and expands the disk. Download, install Wireless Network Watcher and run it to find your Raspberry Pi address (it will show up after first boot is completed).



Type the address into a browser tab to connect to MainsailOS. It will be in an error state but that's OK



Click the Machine Wrench on the left. Open the Update Manager if closed by clicking the arrow on the right. Update all.



Click the Machine Wrench on the left. Open the Update Manager if closed by clicking the arrow on the right and "Update all components". Click "Try Again" when it fails to reconnect.

Installation

These instructions assume the software will run on a Raspberry Pi computer. It is recommended that a Raspberry Pi 2, 3, or 4 computer be used as the host machine (see the FAQ for other machines). Download and install PuTTY and WinSCP

Obtain a Klipper Configuration File

Most Klipper settings are determined by a "printer con. guration file" that will be stored on the Raspberry Pi. An appropriate configuration file can often be found by looking in the Klipper config directory for a file starting with a "printer-" prefix that corresponds to the target printer. The Klipper configuration file contains technical information about the printer that will be needed during the installation.

If there isn't an appropriate printer configuration file in the Klipper config directory then try searching the printer manufacturer's website to see if they have an appropriate Klipper configuration file.

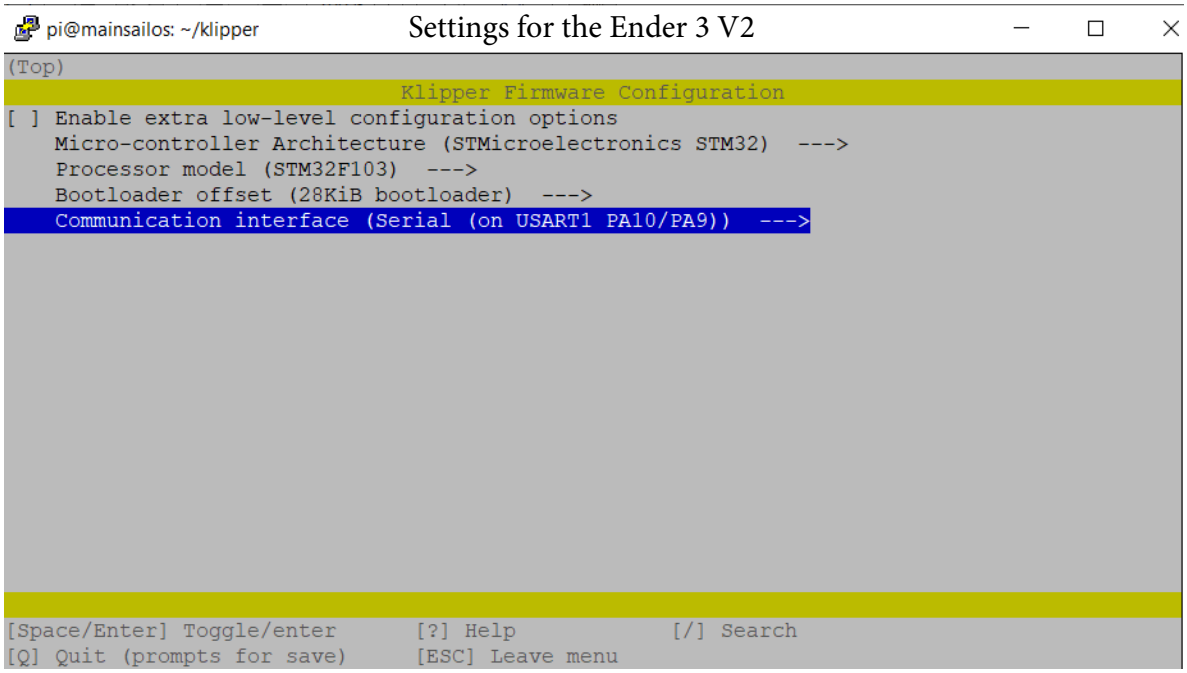
If no configuration file for the printer can be found, but the type of printer control board is known, then look for an appropriate config file starting with a "generic-" prefix. These example printer board files should allow one to successfully complete the initial installation, but will require some customization to obtain full printer functionality.

It is also possible to define a new printer configuration from scratch. However, this requires significant technical knowledge about the printer and its electronics. It is recommended that most users start with an appropriate configuration file. If creating a new custom printer configuration file, then start with the closest example config file and use the Klipper config reference for further information.

Flashing the control board

To compile the micro-controller code, start by running these commands on the Raspberry Pi: or skip these steps by flashing my precompiled Ender-3-V2-Klipper.bin (linked in the description)

```
cd ~/klipper/
make menuconfig
```



The comments at the top of the printer configuration file should describe the settings that need to be set during "make menuconfig". Open the file in a web browser or text editor and look for these instructions near the top of the file. Once the appropriate "menuconfig" settings have been configured, press "Q" to exit, and then "Y" to save. Then run:

```
make
```

The comments at the top of the printer configuration file describe custom steps for "flashing" the printer control board.

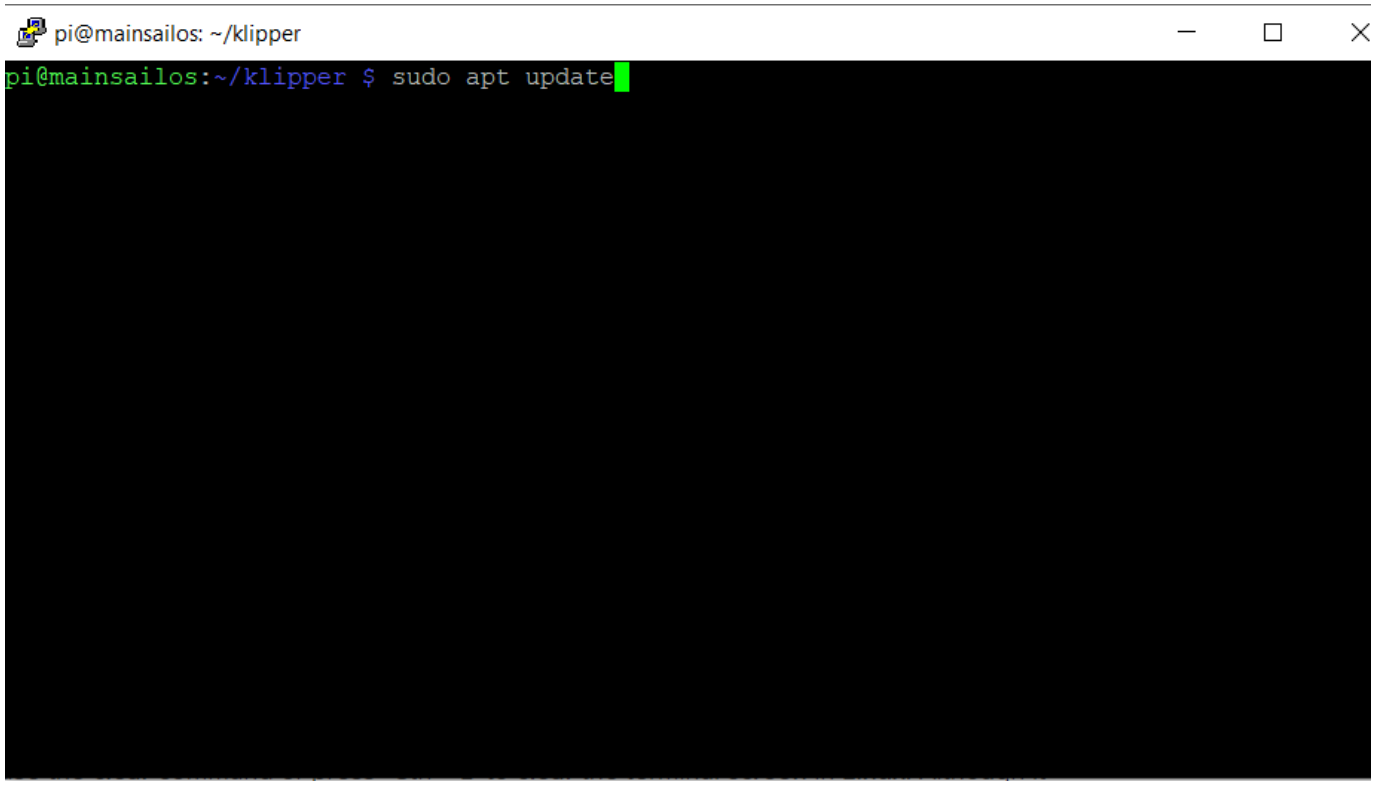
Quick format an 8gb SD card (4096 allocation) , Use WinSCP to get into the Klipper folder in the Out folder look for Klipper.bin and download it to the SD card (If you don't see an Out folder refresh the session) Insert it into the Ender 3 V2 and turn it on, after a minute plug in the usb cable coming from the Raspberry Pi. Check comunication between Klipper and the printer by coping the line below and pasting into the PuTTY session. If you get a file not found error, check your USB connection between the Raspberry Pi and the Ender 3 V2 This messed me up for some time and it was just a loose cable.

```
ls /dev/serial/by-id/*
```

It should report something similar to the following: (if different than the values below copy the output and paste it into the printer.cfg file in the mcu section replacing what's after serial:

```
/dev/serial/by-id/usb-1a86_USB2.0-Serial-if00-port0
```

In the puTTY terminal copy below one line at time, right click to paste and press enter for each follow the prompts.




```
sudo apt update
```

```
sudo apt install python3-numpy python3-matplotlib libatlas-base-dev
```

```
~/klippy-env/bin/pip install -v numpy
```

```
/home/pi/klippy-env/bin/python3 -m pip install --upgrade pip
```

RPi microcontroller software to control the ADXL345

Install the rc script

If you want to use the host as a secondary MCU the klipper_mcu process must run before the klippy process.

After installing Klipper, install the script. run:

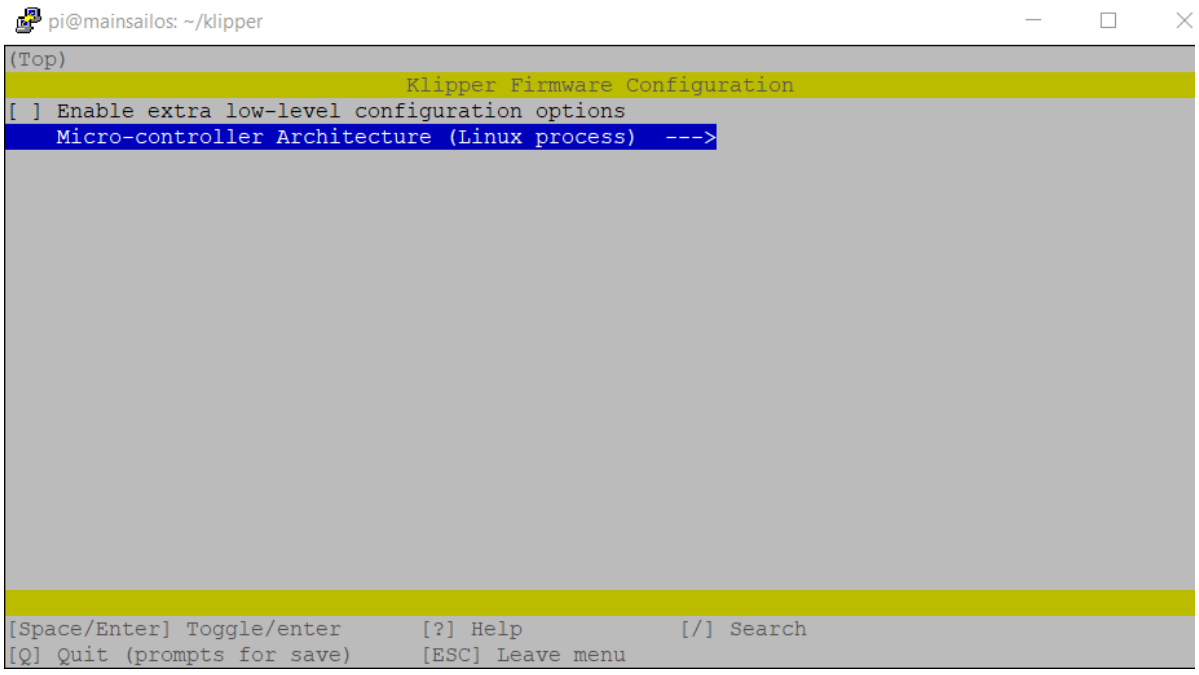
```
cd ~/klipper/
sudo cp "./scripts/klipper-mcu-start.sh" /etc/init.d/klipper_mcu
sudo update-rc.d klipper_mcu defaults
```

Building the micro-controller code

To compile the Klipper micro-controller code, start by configuring it for the "Linux process":

```
cd ~/klipper/
make menuconfig
```

In the menu, arrow down to "Microcontroller Architecture" use right arrow to open, arrow down to "Linux process," press the spacebar then Q and Y to save and exit.



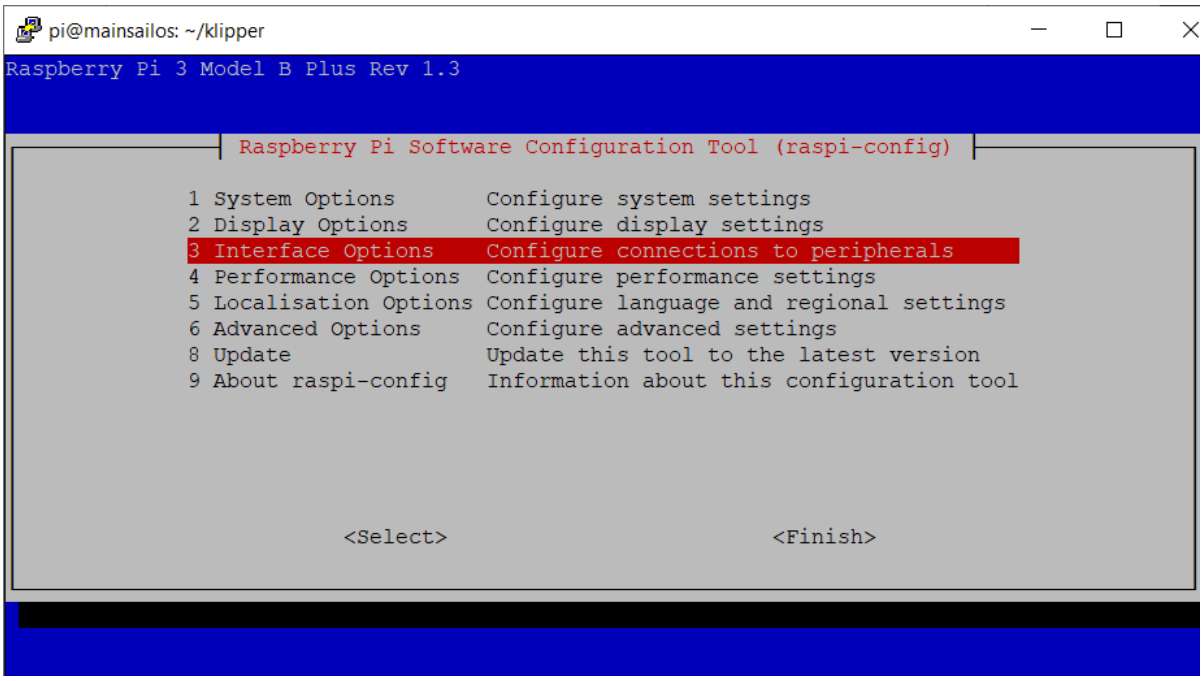
To build and install the new micro-controller code, run:

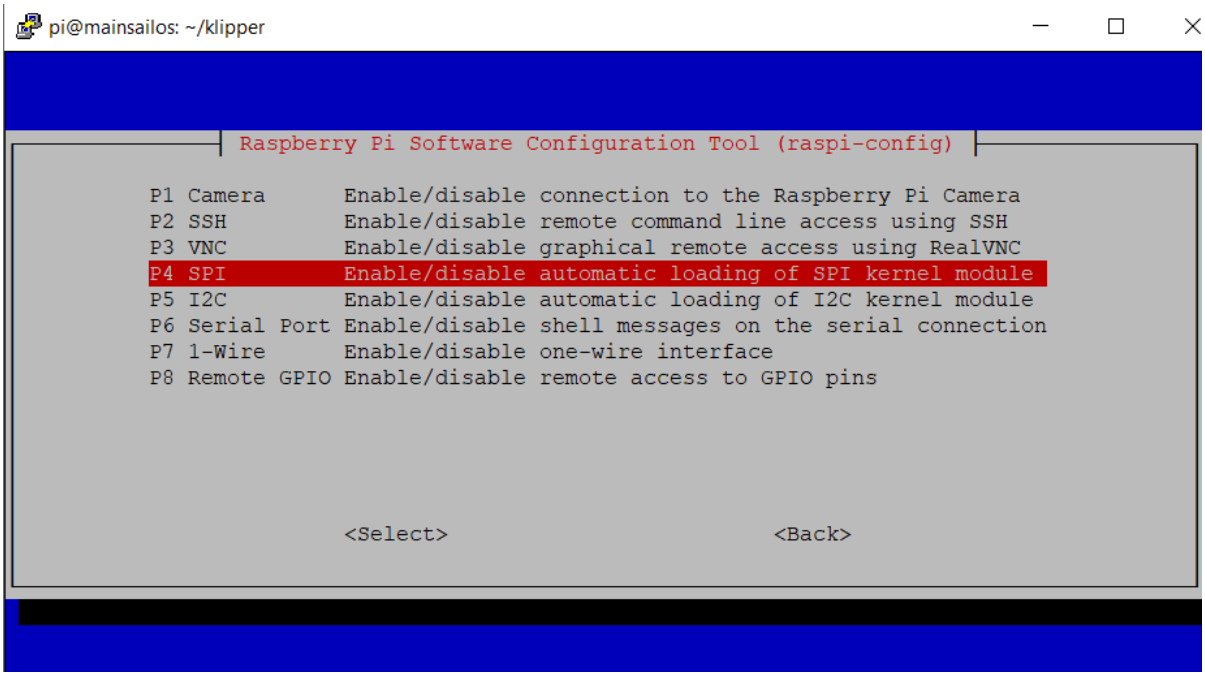
```
sudo service klipper stop
make flash
sudo service klipper start
```

Optional: Enabling SPI

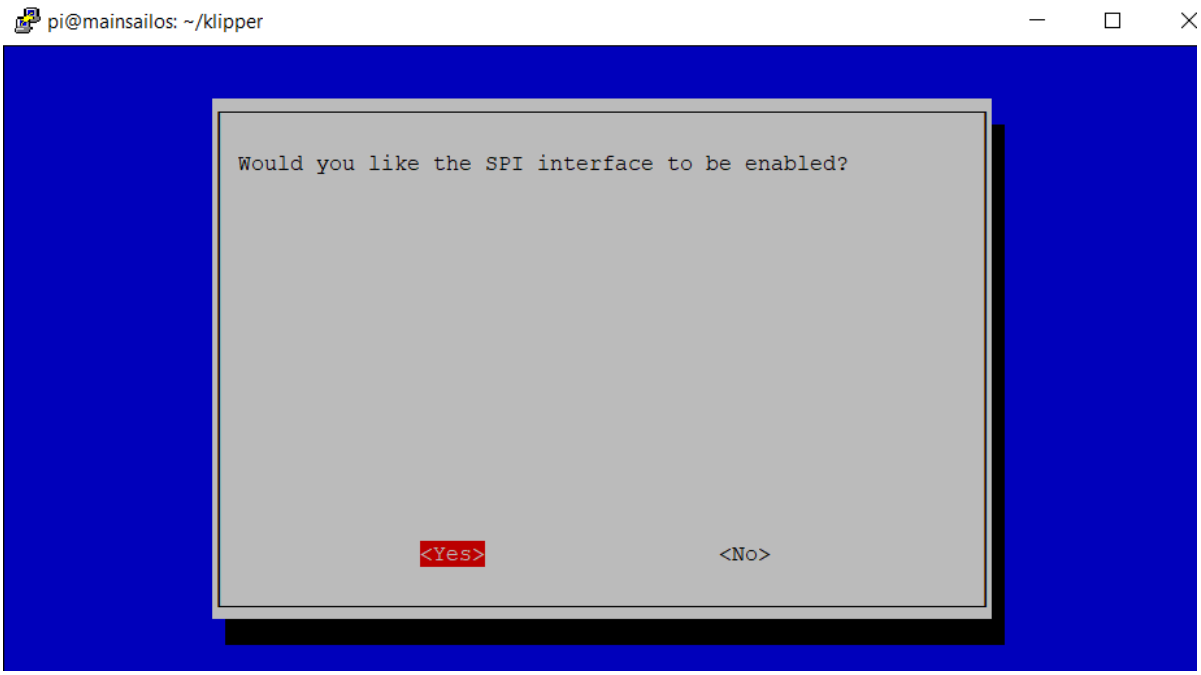
Make sure the Linux SPI driver is enabled by running and enabling SPI under the "Interfacing options" menu. Arrow down and press enter.

```
sudo raspi-config
```

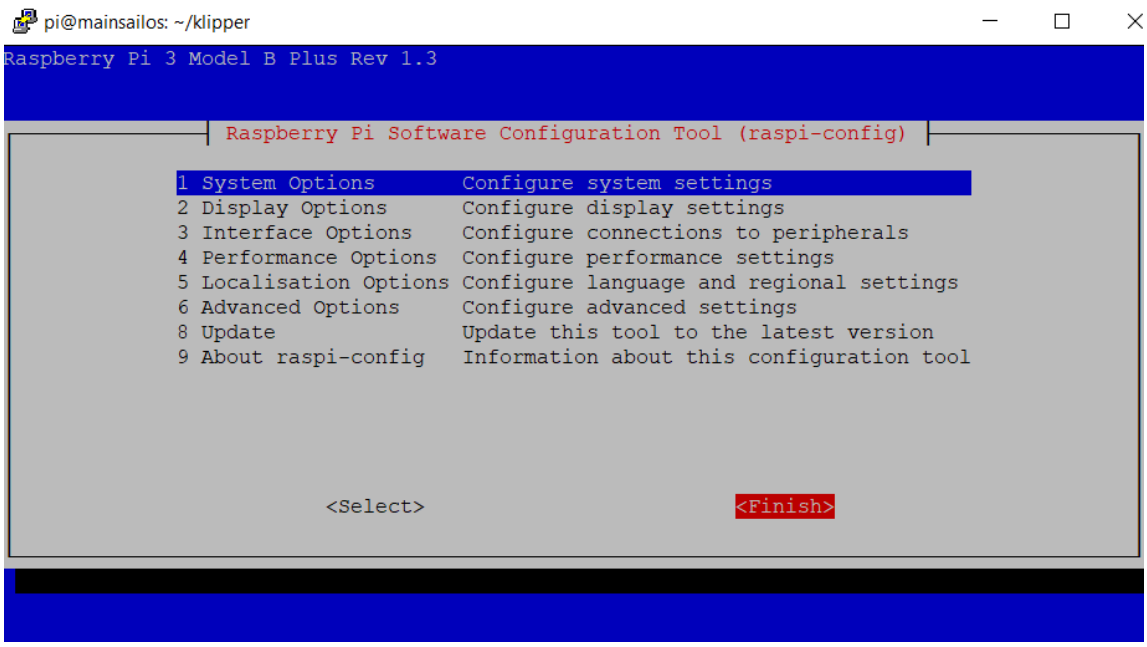




Arrow down to P4 SPI and press enter

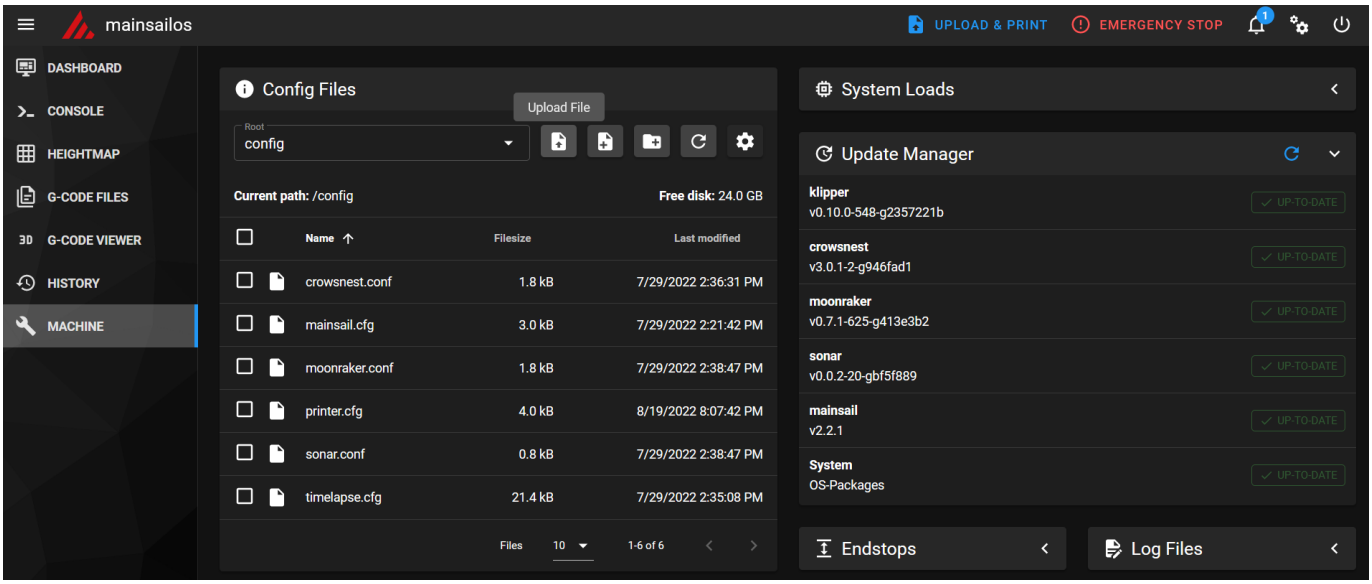


Select <Yes> and press enter. The next screen will say 'The SPI interface is enabled, press enter

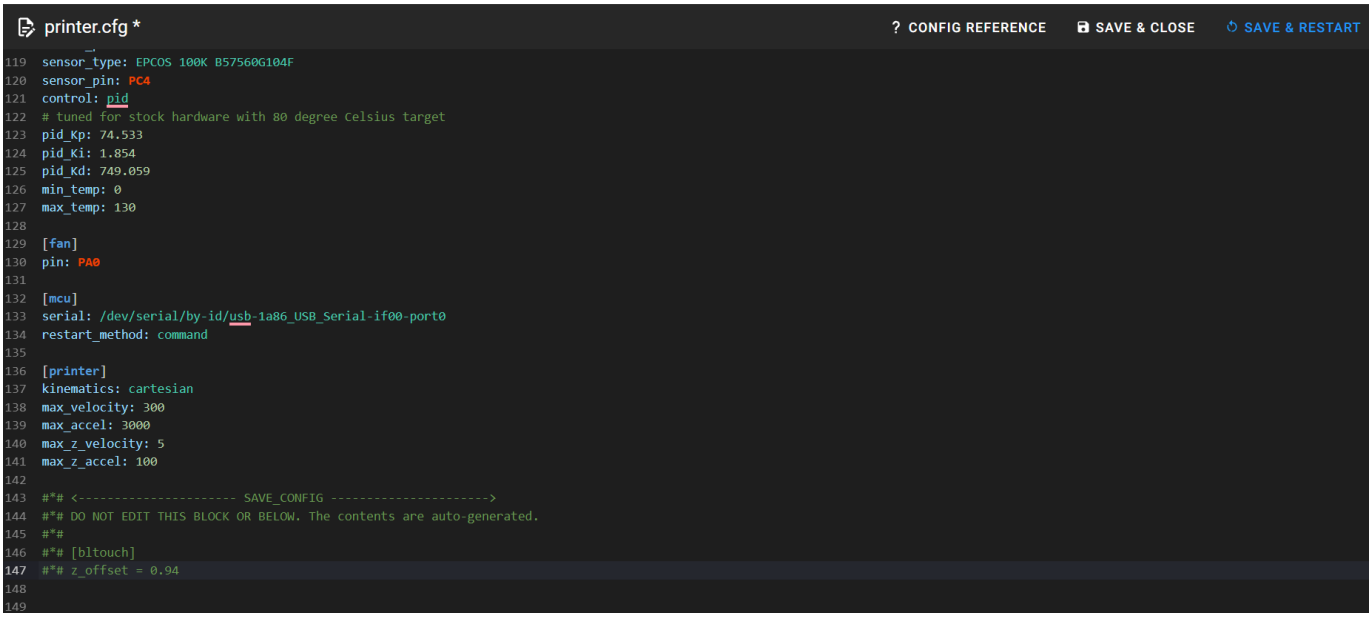


Ubc,!Ubc!up!t fnfdu!=Gjojt i?!qsf t t!foufs, select <Yes>, press enter, press enter, press tab, tab to select <Finish> and enter to exit. At this point you can close down PuTTY.

Click the Upload File Icon (folder with the arrow pointing up) and select my preconfigured Ender 3 V2 printer.cfg to save time. Once uploaded click the power button on the right top corner and select "Firmware Restart". Mainsailos should restart but this time without any errors.



Select Machine again and double click "printer.cfg", scroll down to the bottom to the <...SAVE_CONFIG...> area. You need set your z_offset = "put your number here less the quotes" it should look like the image below. Klipper doesn't use negative numbers for z_offset so -0.94 number would be entered below as 0.94. After entering your z_offset you will need to SAVE & RESTART.



Calibrating probe Z offset

From MainsailOS heat the extruder to 150, remove any filament residue on the nozzle tip (it needs to be clean), set the extruder temperature to 0, Home All, move the print head to the center position. Copy the line below, paste in in the MainsailOS console, and press enter or click the arrow.

```
PROBE_CALIBRATE
```

This tool will perform an automatic probe, then lift the head, move the nozzle over the location of the probe point, and start the manual probe tool. If the nozzle does not move to a position above the automatic probe point, then `ABORT` the manual probe tool and perform the XY probe offset calibration.

Once the manual probe tool is over the probe point place a 0.15 feeler gauge under the nozzle. Use one the of three rectangle measuring tools (2,4,6mm) linked in the video description. Copy the text below, paste, it in the Mainsailos Console ,and enter or click the send arrow. Adjust the movement values if needed. In my case my gap was more than 5mm so I used a combination of the following values to make the movements to my target z_offset. Use them in any order needed.

```
TESTZ Z=-3
```

```
TESTZ Z=-1
```

```
TESTZ Z=-3
```

```
TESTZ Z=-.1
```

```
TESTZ Z=+
```

```
TESTZ Z=-
```

When you finished with the adjustments copy, paste, enter or arrow click the following one at a time into the Mainsailos Console

```
ACCEPT
```

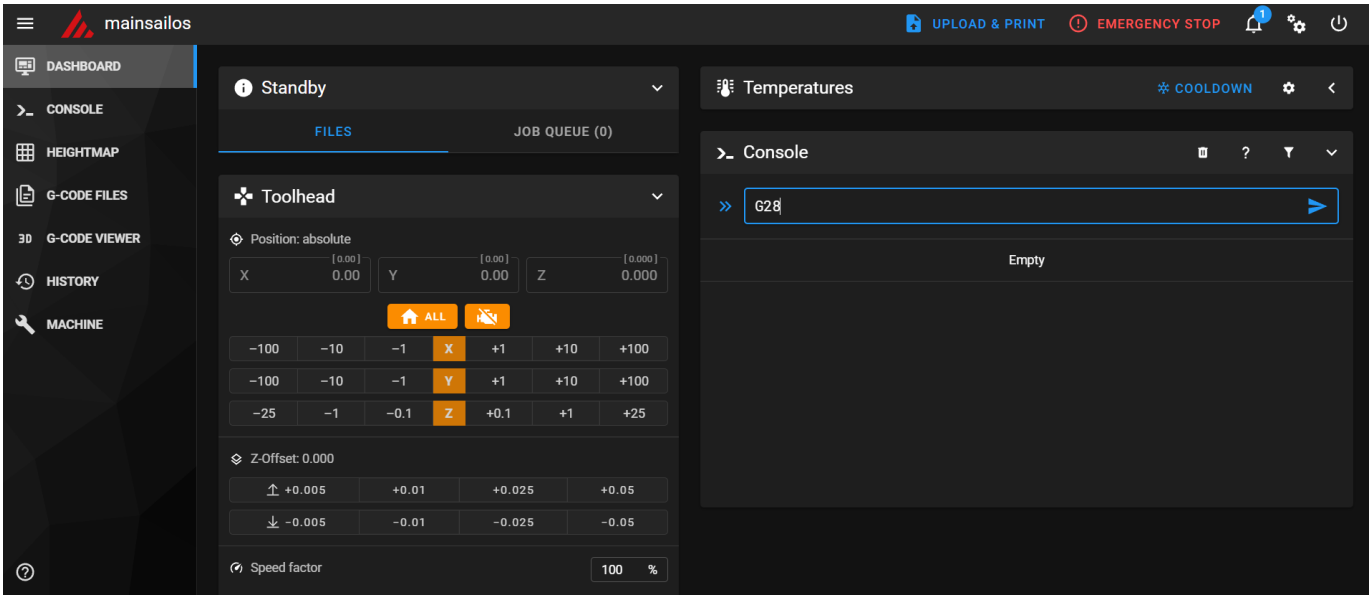
```
SAVE_CONFIG
```

Note that if a change is made to the printer's motion system, hotend position, or probe location then it will invalidate the results of PROBE_CALIBRATE.

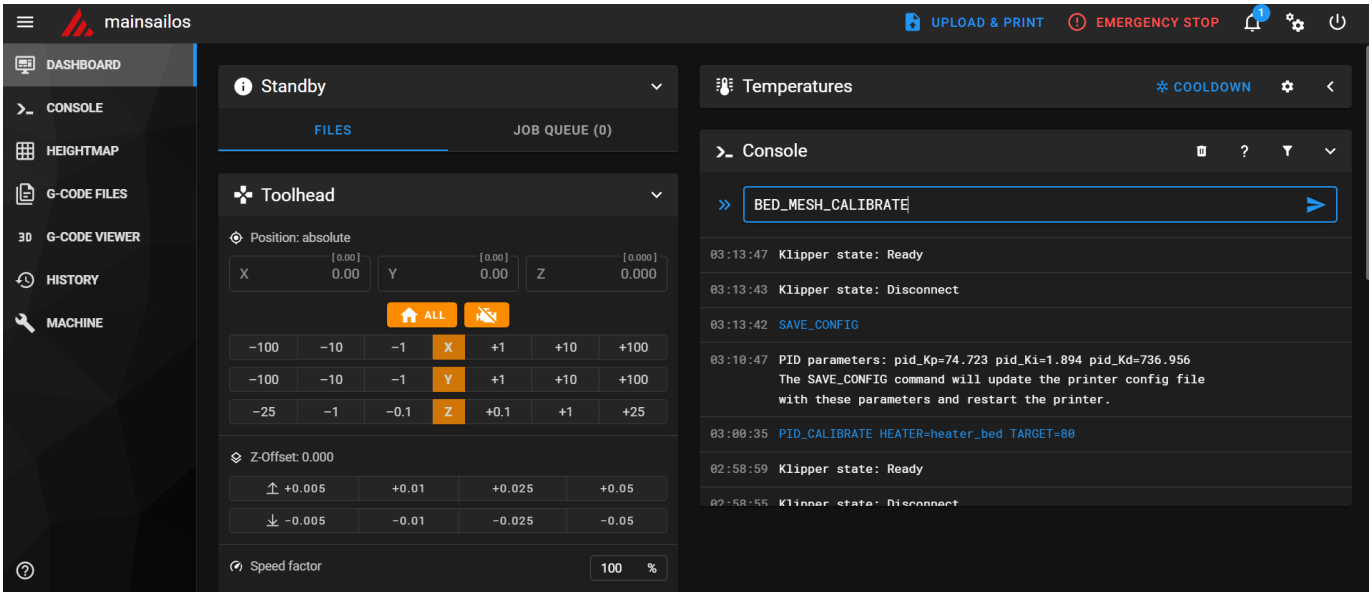
If the probe has an X or Y offset and the bed tilt is changed (eg, by adjusting bed screws, running DELTA_CALIBRATE, running Z_TILT_ADJUST, running QUAD_GANTRY_LEVEL, or similar) then it will invalidate the results of PROBE_CALIBRATE. After making any of the above adjustments it will be necessary to run PROBE_CALIBRATE again.

To create a bed mesh copy, paste, the lines below one at a time into the console, wait for each to finish press enter or click the send arrow.

```
G28
```

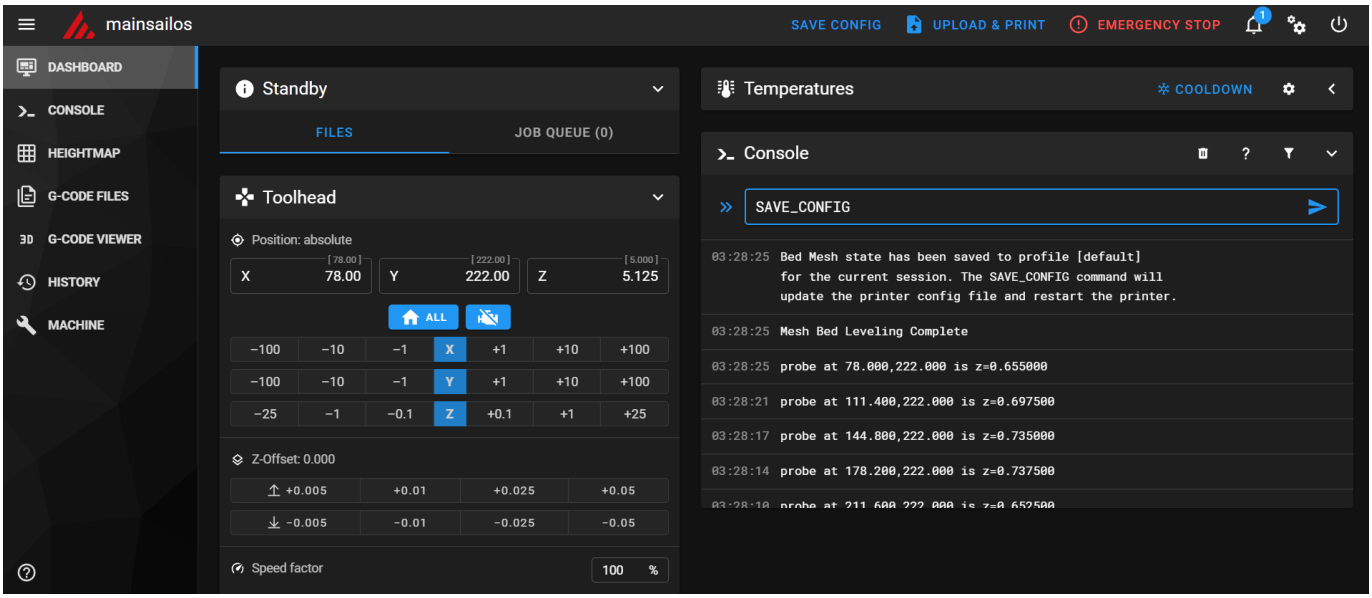



```
BED_MESH_CALIBRATE
```



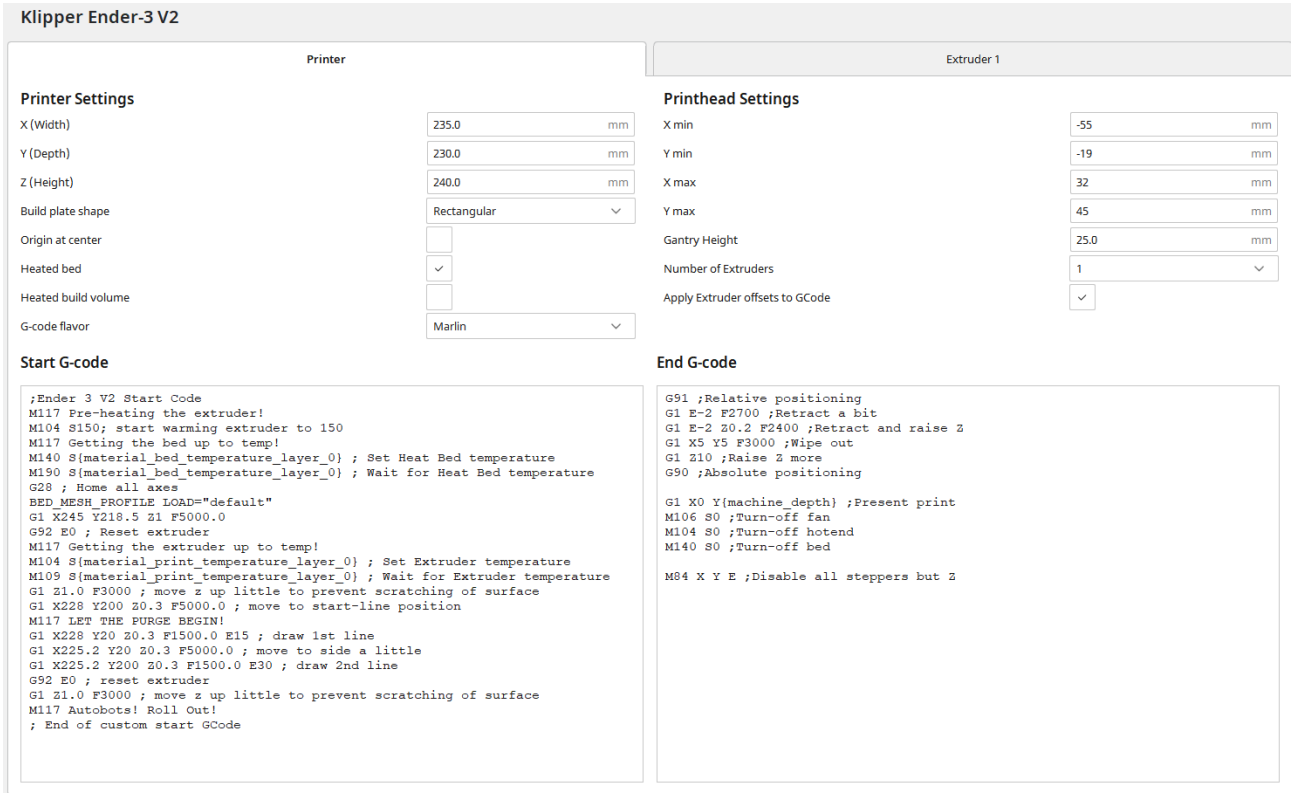
When completed copy, paste the line below into the console, and press enter or click the send arrow

```
SAVE_CONFIG
```



Open CURA and go into your manage printers area, copy and paste the following below after the G28 in your Start G-code. This will load the bed mesh you created before starting your print

```
BED_MESH_PROFILE LOAD="default"
```

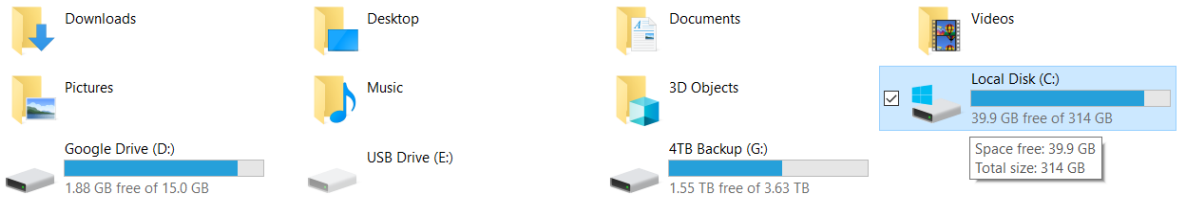


My complete Start G-code works great with Klipper, give it a try.

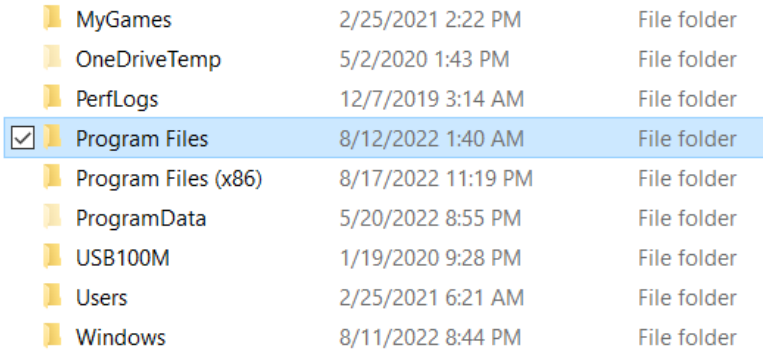
```
;Ender 3 V2 Start Code
M117 Pre-heating the extruder!
M104 S150; start warming extruder to 150
M117 Getting the bed up to temp!
M140 S{material_bed_temperature_layer_0} ; Set Heat Bed temperature
M190 S{material_bed_temperature_layer_0} ; Wait for Heat Bed temperature
G28 ; Home all axes
BED_MESH_PROFILE LOAD="default"
G1 X245 Y218.5 Z1 F5000.0
G92 E0 ; Reset extruder
M117 Getting the extruder up to temp!
M104 S{material_print_temperature_layer_0} ; Set Extruder temperature
M109 S{material_print_temperature_layer_0} ; Wait for Extruder temperature
G1 Z1.0 F3000 ; move z up little to prevent scratching of surface
G1 X228 Y200 Z0.3 F5000.0 ; move to start-line position
M117 LET THE PURGE BEGIN!
G1 X228 Y20 Z0.3 F1500.0 E15 ; draw 1st line
G1 X225.2 Y20 Z0.3 F5000.0 ; move to side a little
G1 X225.2 Y200 Z0.3 F1500.0 E30 ; draw 2nd line
G92 E0 ; reset extruder
G1 Z1.0 F3000 ; move z up little to prevent scratching of surface
M117 Autobots! Roll Out!
; End of custom start GCode
```

Enabling CURA Support for MainsailOS Connection

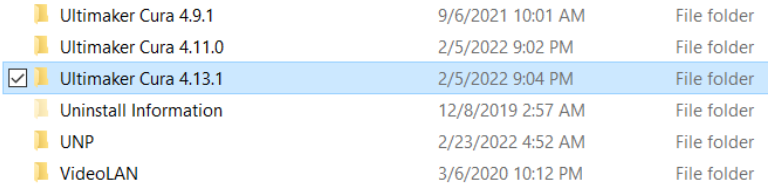
Using your computer file explorer double click your Local Drive C:



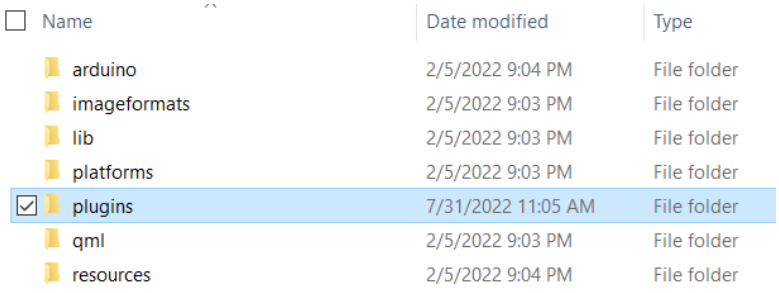
Double click Program Files



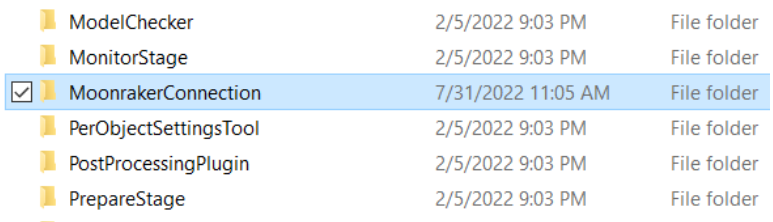
Double click your CURA version folder



Double click the plugins folder

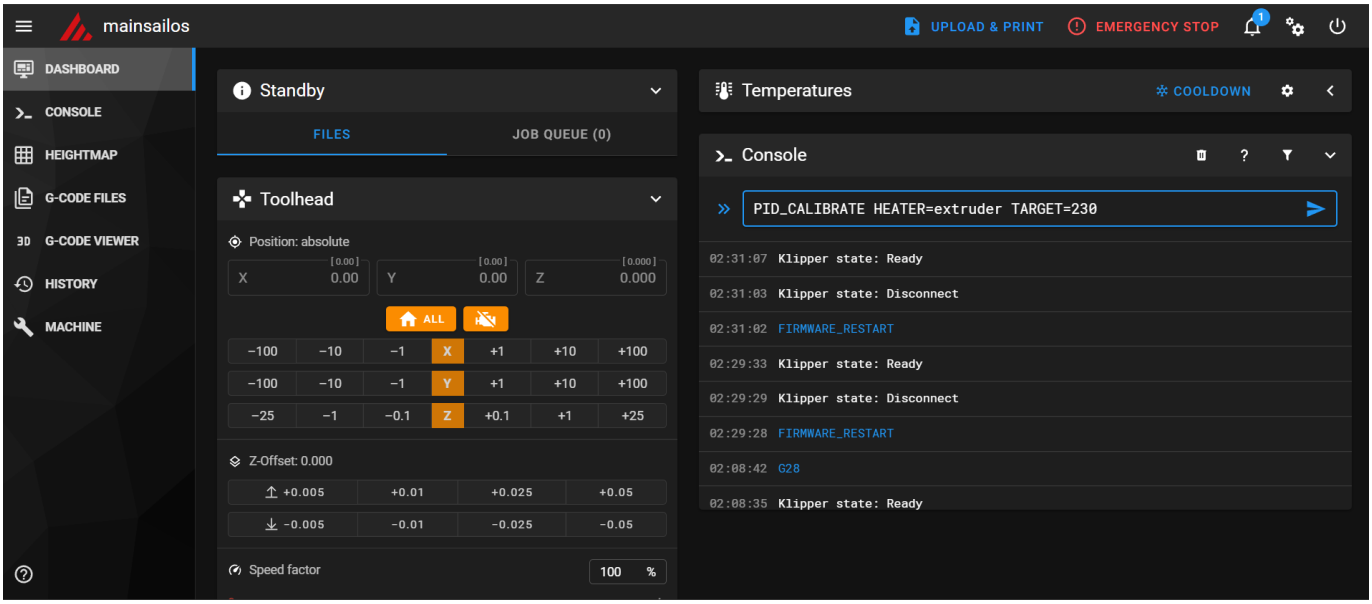


Unzip the MoonrakerConnection.zip file included in the video description and past the folder into the plugins direction. CURA needs to be restarted if open for the MoonrakerConnection plugin to load



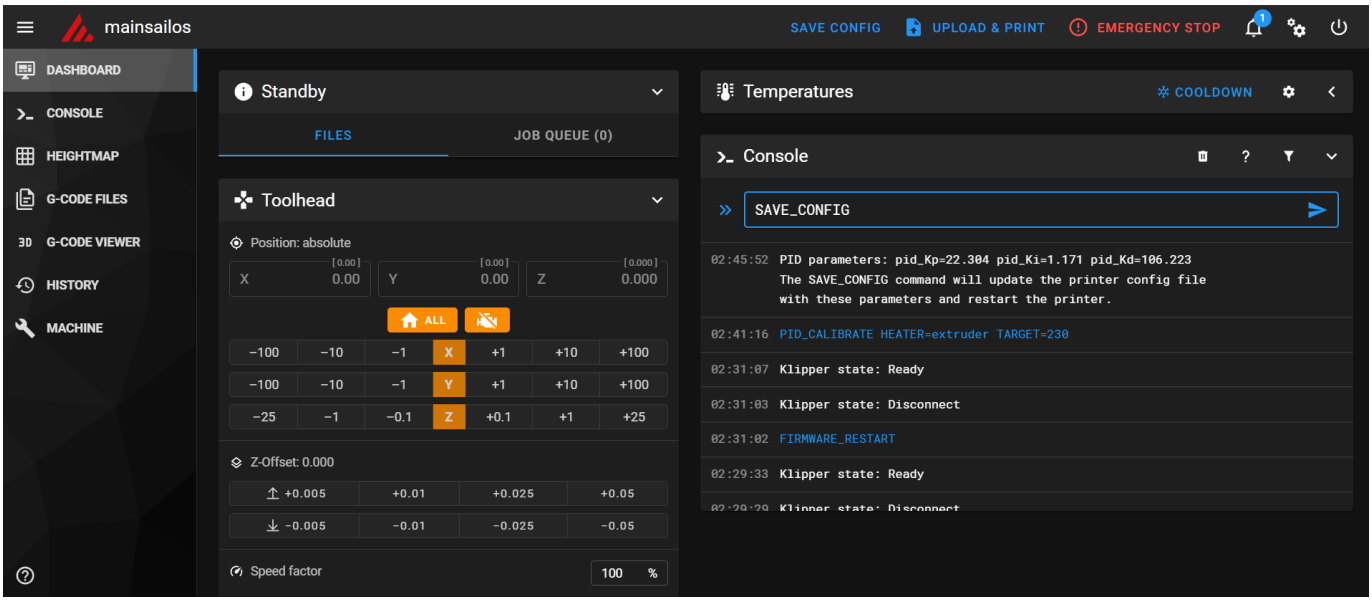
Let's PID tune your Ender 3 V2, Select the DASHBOARD on the left, in the console box on the right paste the following below. Before pressing enter or click the send arrow on the right edit the temp value to match your print temperature and press enter or click send. I use SUNLU PETG and print at 230c.

```
PID_CALIBRATE HEATER=extruder TARGET=230
```



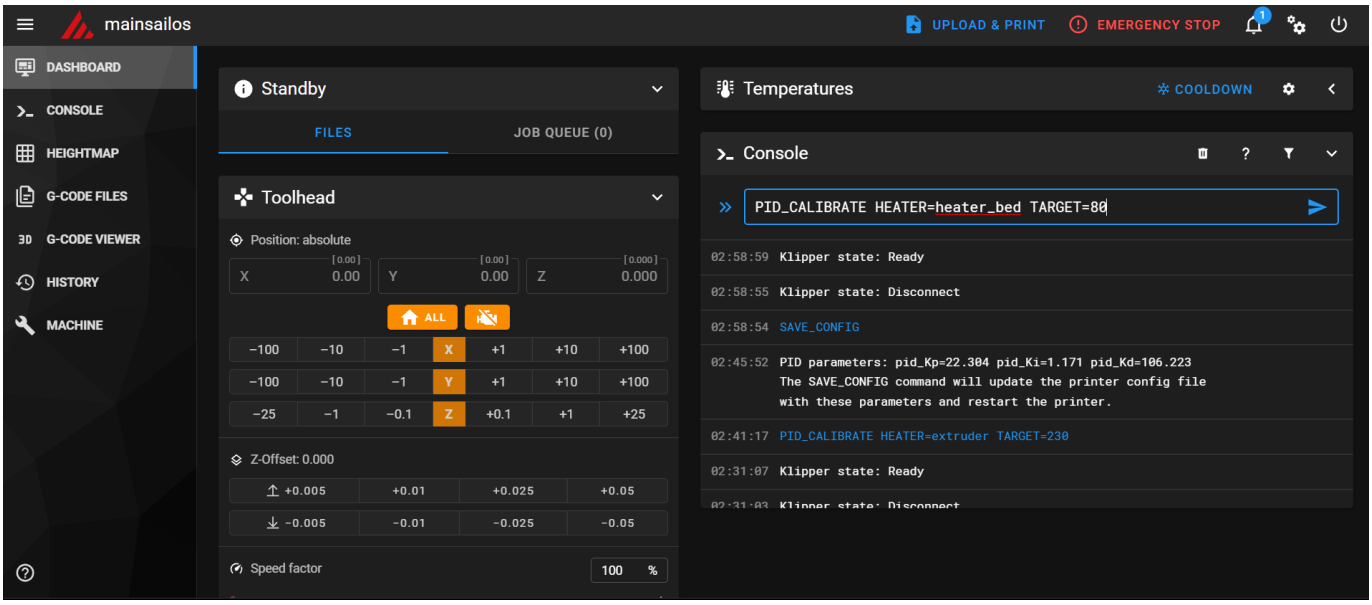
When completed copy, paste the line below into the console, and press enter or click the send arrow

```
SAVE_CONFIG
```



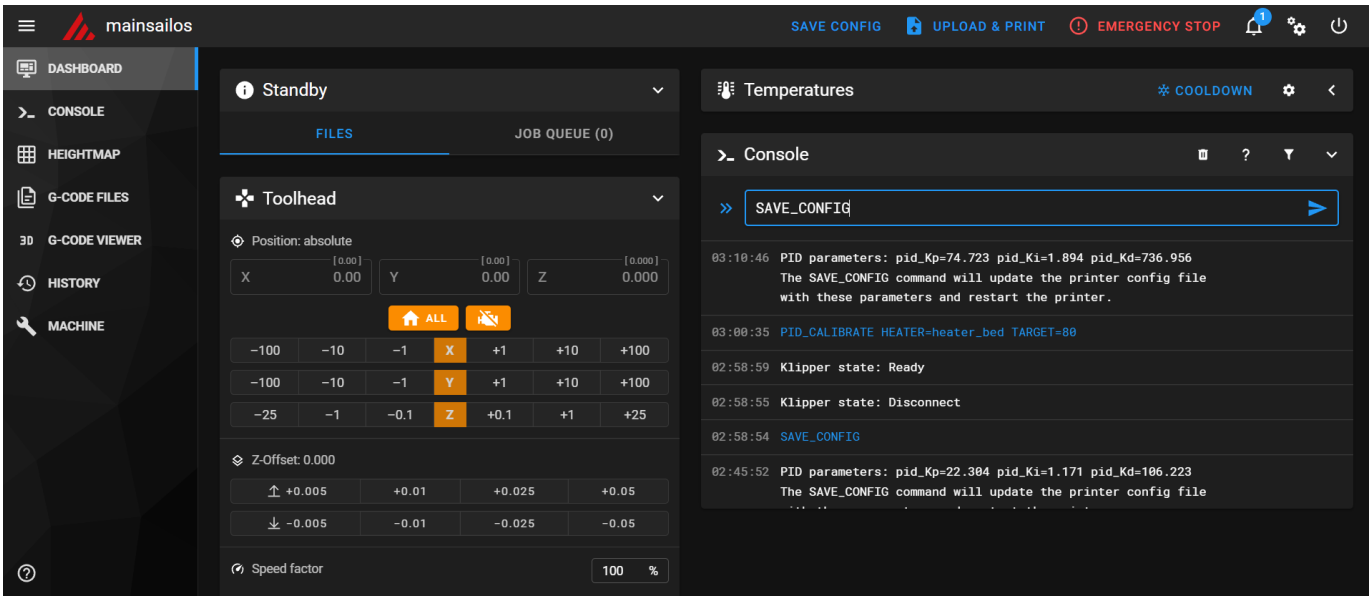
Paste the following below. Before pressing enter of click the send arrow on the right edit the temp value to match your bed temperature and press enter or click send. I use SUNLU PETG bed temp is 80c.

```
PID_CALIBRATE HEATER=heater_bed TARGET=80
```



When completed copy, paste the line below into the console, and press enter or click the send arrow

```
SAVE_CONFIG
```



Rotation distance

Stepper motor drivers on Klipper require a `rotation_distance` parameter in each stepper config section. The `rotation_distance` is the amount of distance that the axis moves with one full revolution of the stepper motor. This document describes how one can configure this value.

Obtaining rotation_distance from steps_per_mm (or step_distance)

The designers of your 3d printer originally calculated `steps_per_mm` from a rotation distance. If you know the steps_per_mm then it is possible to use this general formula to obtain that original rotation distance:

```
rotation_distance = <full_steps_per_rotation> * <microsteps> / <steps_per_mm>
```

Example

```
34.406 (rotation distance) = 200 (full steps per rotation) * 16 (microsteps) / 93
(steps per mm)
```

```
200 (full steps per rotation) * 16 (microsteps) = 3200
```

```
3200 / 93 (default Creality e-steps) = 34.409 (rotation distance)
```

The `<full_steps_per_rotation>` setting is determined from the type of stepper motor. Most stepper motors are "1.8 degree steppers" and therefore have 200 full steps per rotation (360 divided by 1.8 is 200). Some stepper motors are "0.9 degree steppers" and thus have 400 full steps per rotation. Other stepper motors are rare. If unsure, do not set full_steps_per_rotation in the config file and use 200 in the formula above.

The `<microsteps>` setting is determined by the stepper motor driver. Most drivers use 16 microsteps. If unsure, set `microsteps: 16` in the config and use 16 in the formula above.

Almost all printers should have a whole number for `rotation_distance` on X, Y, and Z type axes. If the above formula results in a rotation_distance that is within .01 of a whole number then round the final value to that whole_number.

Calibrating rotation_distance on extruders

On an extruder, the `rotation_distance` is the amount of distance the filament travels for one full rotation of the stepper motor. The best way to get an accurate value for this setting is to use a "measure and trim" procedure.

First start with an initial guess for the rotation distance. This may be obtained from steps_per_mm or by inspecting the hardware.

Then use the following procedure to "measure and trim":

1. Make sure the extruder has filament in it, the hotend is heated to an appropriate temperature, and the printer is ready to extrude.
2. Use a marker to place a mark on the filament around 110mm from the intake of the extruder body. Then use a digital calipers to measure the actual distance of that mark as precisely as one can. Note this as `<initial_mark_distance> = 110`.
3. Extrude 100mm of filament with the following command sequence: `G91` followed by `G1 E100 F60`. Note 100mm as `<requested_extrude_distance>`. Wait for the extruder to finish the move (it will take about 50 seconds). It is important to use the slow extrusion rate for this test as a faster rate can cause high pressure in the extruder which will skew the results. (Do not use the "extrude button" on graphical front-ends for this test as they extrude at a fast rate.)
4. Use the digital calipers to measure the new distance between the extruder body and the mark on the filament. Note this as `<distance to mark>`. Then calculate:

   `<initial_mark_distance> - <distance to mark> = actual_extrude_distance`

   Example `110 - 15.21 = 94.79`
5. Calculate rotation_distance as:

   `<previous_rotation_distance> x actual_filament_extruded = total rotations to extrude the actual length of filament`

   Example `33.5 x 94.79 = 3,175.465`

   `total_rotation_rotation_distance / <requested_extrude_distance> = new rotation_distance`

   Round the new rotation_distance to three decimal places.

   Example `3,175.465 / 100 = 31.755`

If the actual_extrude_distance differs from requested_extrude_distance by more than about 2mm then it is a good idea to perform the steps above a second time.

Note: Do *not* use a "measure and trim" type of method to calibrate x, y, or z type axes. The "measure and trim" method is not accurate enough for those axes and will likely lead to a worse configuration. Instead, if needed, those axes can be determined by measuring the belts, pulleys, and lead screw hardware.