

caribou3d

05_Input shaping

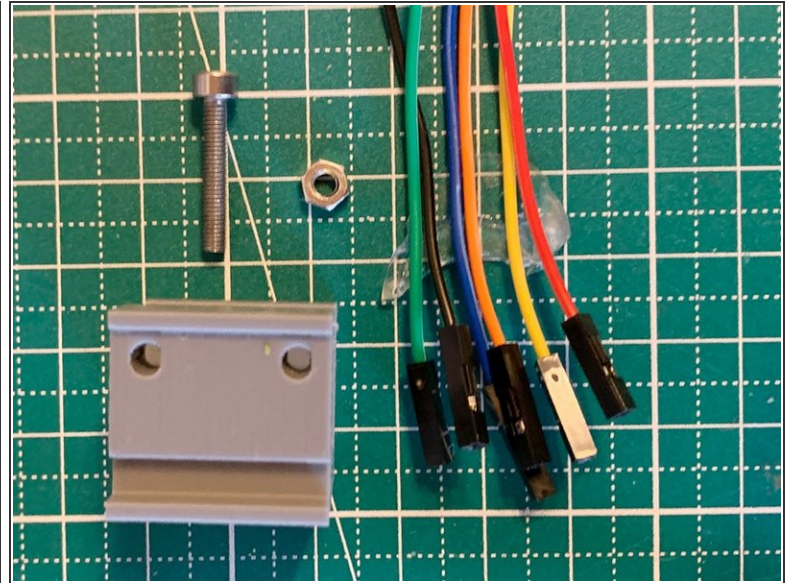
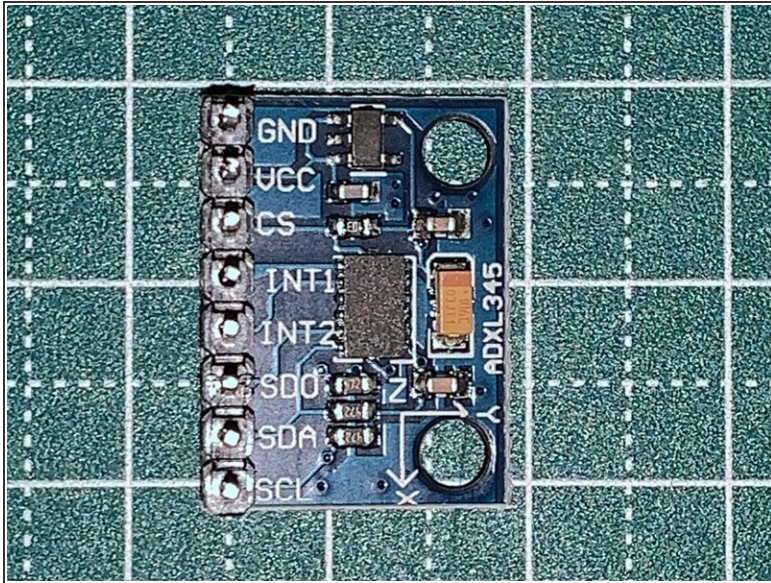
Written By: Abd Ghaffar Othman

Input shaper

INTRODUCTION

Klipper supports the so-called. **Input shaping**. As a result, "ringing" or “ghosting ” can be significantly reduced (especially at high printing speeds). We use an inexpensive acceleration sensor (accelerometer) of type ADXL345 for the X and Y axes to measure the resonances. This tutorial is primarily about the practical implementation. If you want to know more about the topic, you will [here](#) found.

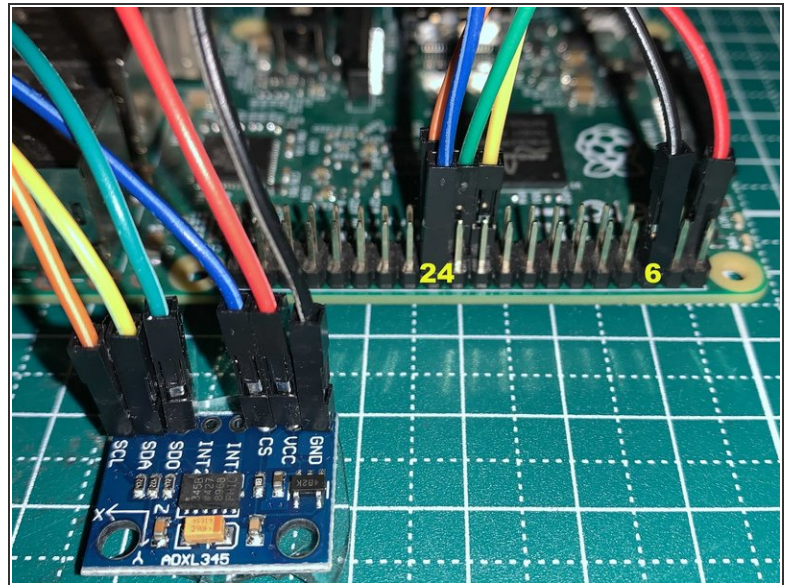
Step 1 — What is needed?



- An ADXL345 module (e.g. available from amazon, cost approx. 2.00 to 5.00 euros)
- ① There are different versions of these modules. The order of the pin assignment can therefore differ from the photo.
- A printed holder for the Y axis, stl download from [here](#). A nut M3 and a screw M3x12.
- Six dupont cables female / female, minimum length 40cm
- Possibly. a soldering iron and some solder.

Step 2 — Cabling

ADXL345 pin	RPi pin	
		+ 3.3 V (SDA) GPIO 2 (SCL) GPIO 3 GND GPIO 17 GPIO 27 GPIO 22 + 3.3 V (MOSI) GPIO 10 (MISO) GPIO 9 (SCLK) GPIO 11 GND ID_SD GPIO 5 GPIO 6 GPIO 13 GPIO 19 GPIO 26 GND 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 + 5 V + 5 V GND GPIO 14 (TXD) GPIO 15 (RXD) GPIO 18 GPIO 23 GPIO 24 GND GPIO 25 GPIO 8 (CE0) GPIO 7 (CE1) ID_SC GND GPIO 12 GND GPIO 16 GPIO 20 GPIO 21
3V3 (or VCC)	01	
GND	06	
CS	24	
SDO	21	
SDA	19	
SCL	23	



- The connector strip is not yet soldered on most ADXL345 modules. Solder them onto the top of the board and pinch protruding tips on the bottom with a small pair of pliers.
 - Disconnect the printer and Raspberry Pi from the power.
 - Connect the Raspberry Pi and the ADXL345 module to the Dupont cables as shown in the sketch and photo.
- ⚠ Check the cabling! If the cabling is faulty, the pi or accelerometer can be damaged.

Step 3 — Software preparation

```

pi@mainailos:~$ Using username "pi".
pi@192.168.1.07:~$ password:
Linux mainailos 5.10.63-v7+ #1457 SMP Tue Sep 28 11:25:31 BST 2021 armv7l

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

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.

Last login: Fri Nov 19 17:54:24 2021 from 192.168.1.10

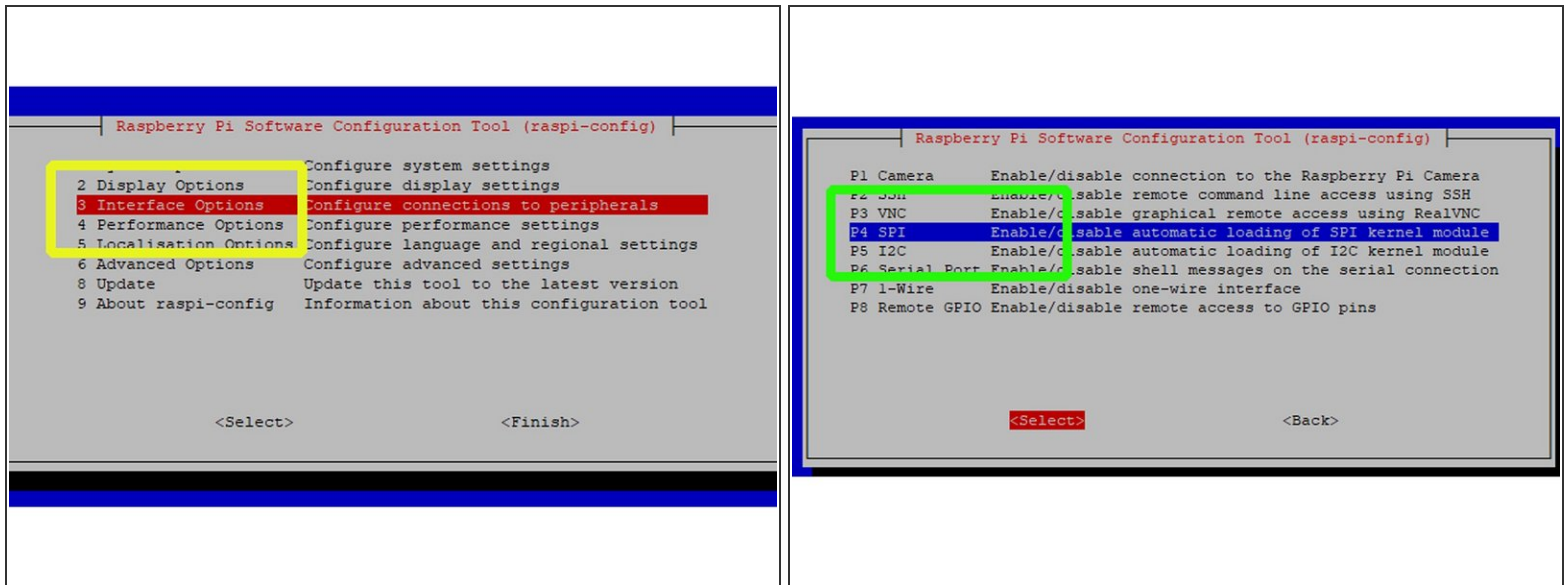
SSH is enabled and the default password for the 'pi' user has not been changed.
This is a security risk - please login as the 'pi' user and type 'passwd' to set
a new password.

pi@mainailos:~$ ~/klippy-env/bin/pip install -v numpy
Found link https://www.piwheels.org/simple/pip/pip-9.0.0-py2.py3-none-any.whl#sha256=856ac18ca01e712745ef83192dc67cc7d3ab663f4c13b1ec15e36db4de574 (from ht
https://www.piwheels.org/simple/pip/) (requires-python:>=2.6,!=3.0.*,!=3.1.*,!=3.2
*), version: 9.0.0
Found link https://www.piwheels.org/simple/pip/pip-9.0.1-py2.py3-none-any.whl#sha256=90b762c0a8460c303089d5d0be034fb15a5ea2b75bdf56540421f542febf0 (from ht
https://www.piwheels.org/simple/pip/) (requires-python:>=2.6,!=3.0.*,!=3.1.*,!=3.2
*), version: 9.0.1
Found link https://www.piwheels.org/simple/pip/pip-9.0.2-py2.py3-none-any.whl#sha256=b135491ad0061f39719e8472d8abb59c613b16a2b8609c332db74d1cd208ab2 (from ht
https://www.piwheels.org/simple/pip/) (requires-python:>=2.6,!=3.0.*,!=3.1.*,!=3.2
*), version: 9.0.2
Found link https://www.piwheels.org/simple/pip/pip-9.0.3-py2.py3-none-any.whl#sha256=ced34350e00c31e77d3aded78e0c3291654937e7373032fda04e803e5 (from ht
https://www.piwheels.org/simple/pip/) (requires-python:>=2.6,!=3.0.*,!=3.1.*,!=3.2
*), version: 9.0.3
Given no hashes to check 222 links for project 'pip': discarding no candidates
Removed build tracker: /tmp/pip-req-tracker-cv7oox
pi@mainailos:~$ sudo apt install python-numpy python-matplotlib
[sudo] password for pi:
Reading package lists... done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:

```

- ⚠️ Go to "Safe number" and make a 1: 1 copy of the MicroSD, which is located in the Raspberry Pi. This works e.g. with the tool **Win32DiskImager** without problems under Windows.
- We also need the tools under Windows **Putty** and **WinSCP**, that we already know from the other tutorials.
- Reconnect the pi and printer and boot with the backup copy. We first log in to our clipper system via Putty via SSH connection.
- First, the NumPy Python program library must be installed. We give the command **~/klippy-env / bin / pip install -v numpy** and confirm with Enter. The installation can take up to 20 minutes.
- After that we give **sudo apt install python-numpy python-matplotlib** and confirm again with Enter. Now further, program-related dependencies are installed.
- We answer the following query with "Yes".

Step 4 — Activate SPI



- ① For communication between the accelerometer and the pi, we have to activate the pi's SPI interface.
- We first give in Putty **sudo raspi-config** enter, confirm with Enter and then enter our password.
- In the configuration tool we first select point 3 **Interface options**.
- Another configuration window opens and we choose **P4 SPI**. We go to "Select" and save the change.

Step 5 — Create virtual printers

```

pi@mainailos: ~/klipper
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/*copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Nov 17 16:53:51 2021 from 192.168.1.10

pi@mainailos: ~$ cd ~/klipper/
pi@mainailos: ~/klipper$ sudo cp ../scripts/klipper-mcu-start.sh /etc/init.d/klipper_mcu
[sudo] password for pi:
pi@mainailos: ~/klipper$ sudo update-rc.d klipper_mcu defaults
Configuration saved to '/home/pi/klipper/.config'
Creating symbolic link out/board
Loaded configuration '/home/pi/klipper/.config'
pi@mainailos: ~/klipper$

pi@mainailos: ~/klipper
Klipper Firmware Configuration
[Top]
[*] Enable extra low-level configuration options
[ ] Micro-controller Architecture (Linux process) -->
[ ] GPIO pins to set at micro-controller startup (NEW)

[Space/Enter] Toggle/enter      [?] Help      [/] Search
[Q] Quit (prompts for save)    [ESC] Leave menu

pi@mainailos: ~/klipper
klipper_mcu
[sudo] password for pi:
pi@mainailos: ~/klipper$ sudo update-rc.d klipper_mcu defaults
pi@mainailos: ~/klipper$ make menuconfig
Using default symbol values (no '/home/pi/klipper/.config')
Configuration saved to '/home/pi/klipper/.config'
Creating symbolic link out/board
Loaded configuration '/home/pi/klipper/.config'
Configuration (/home/pi/klipper/.config) was not saved
pi@mainailos: ~/klipper$ sudo service klipper stop
pi@mainailos: ~/klipper$ sudo usermod -a -G tty pi
pi@mainailos: ~/klipper$ make flash
Building out/autocalc.o
Compiling out/src/sched.o
Compiling out/src/command.o
Compiling out/src/basecmd.o
Compiling out/src/debugcmds.o
Compiling out/src/initial_pins.o
Compiling out/src/gpiocmds.o
Compiling out/src/stepper.o

```

- We log in again about Putty and give **cd ~ / klipper/** a plus enter. After that **sudo cp** **"../scripts/klipper-mcu-start.sh" /etc/init.d/klipper_mcu** plus enter and password confirmation followed by **sudo update-rc.d klipper_mcu defaults** plus enter and **make menuconfig** plus enter.
- A configuration window opens where we **Enable extra low level** and **MicroController Architecture (Linux process)** activate. We save via "Quit".
- We give then **sudo service klipper stop** plus enter, followed by **sudo usermod -a -G tty pi** plus enter . With **make flash** plus Enter, the virtual printer is created. About **sudo service klipper start** plus Enter, Klipper is restarted.

Step 6 — Changes in printer.cfg

printer.cfg

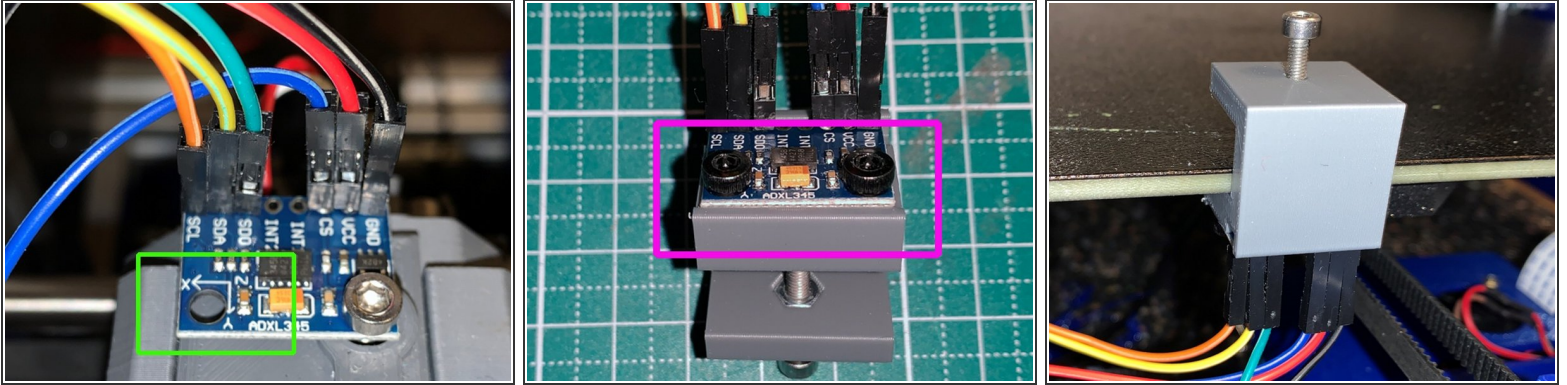
```
1 [mcu]
2 baud: 250000
3 serial: /dev/serial/by-id/usb-Prusa_Research__prusa3d.com_Original_Prusa_i3_MK3_CZPX1218X004XK53581-1f00
4
5 [mcu rpi]
6 serial: /tmp/klipper_host_mcu
7
8 [adxl345]
9 cs_pin: rpi:None
10
11 [resonance_tester]
12 accel_chip: adxl345
13 probe_points:
14     100,100,20 # an example
15
16 [printer]
17 kinematics: cartesian
18 max_velocity: 300
19 max_accel: 10000
20 max_accel_to_decel: 10000
21 max_z_velocity: 20
22 max_z_accel: 300
23
```

printer.cfg

```
1 [mcu]
2 baud: 250000
3 serial: /dev/serial/by-id/usb-Prusa_Research__prusa3d.com_Original_Prusa_i3_MK3_CZPX1218X004XK53581-1f00
4
5 [mcu rpi]
6 serial: /tmp/klipper_host_mcu
7
8 [adxl345]
9 cs_pin: rpi:None
10
11 [resonance_tester]
12 accel_chip: adxl345
13 probe_points:
14     100,100,20 # an example
15
16 [printer]
17 kinematics: cartesian
18 max_velocity: 300
19 max_accel: 10000
20 max_accel_to_decel: 10000
21 max_z_velocity: 20
22 max_z_accel: 300
23
```

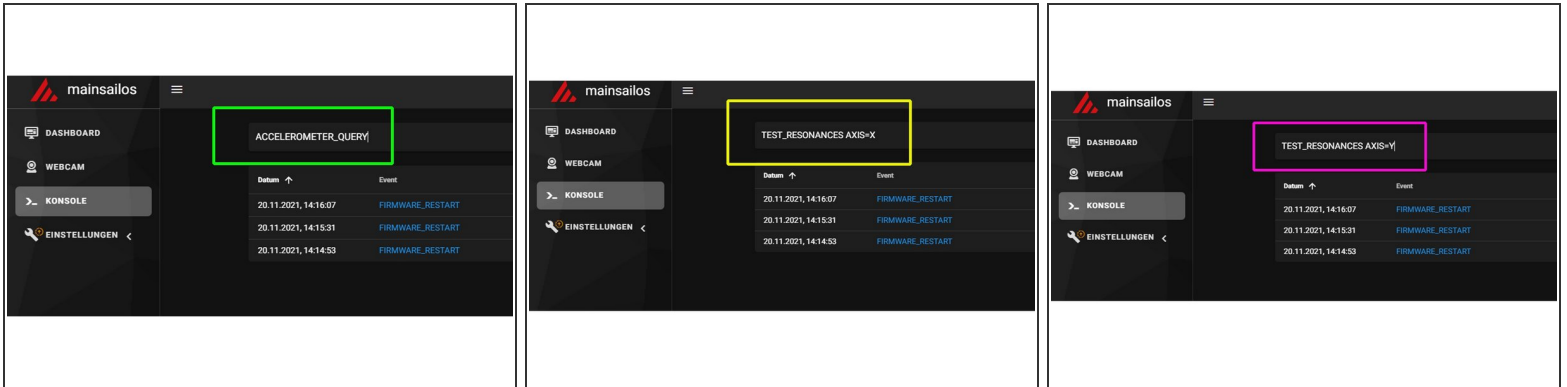
- ❗ Changes to the configuration are required for measurements with the ADXL345. These are taken back after the measurement.
- We now open in Mainsail under "Machine" **printer.cfg** and enter the following lines: [mcu rpi] serial: / tmp / klipper_host_mcu [adxl345] cs_pin: rpi: None [resonance_tester] accel_chip: adxl345 probe_points: 100,100,20 # an example
 - Orientate yourself when formatting on the screenshot shown!
 - Then put **max_accel** and **max_accel_to_decel** on **10000** up.
 - ⚠ After the measurement, make sure to reset these values to the normal values or use the original SD again.
 - Save the changes.

Step 7 — Installation of the ADXL345 on X and Y



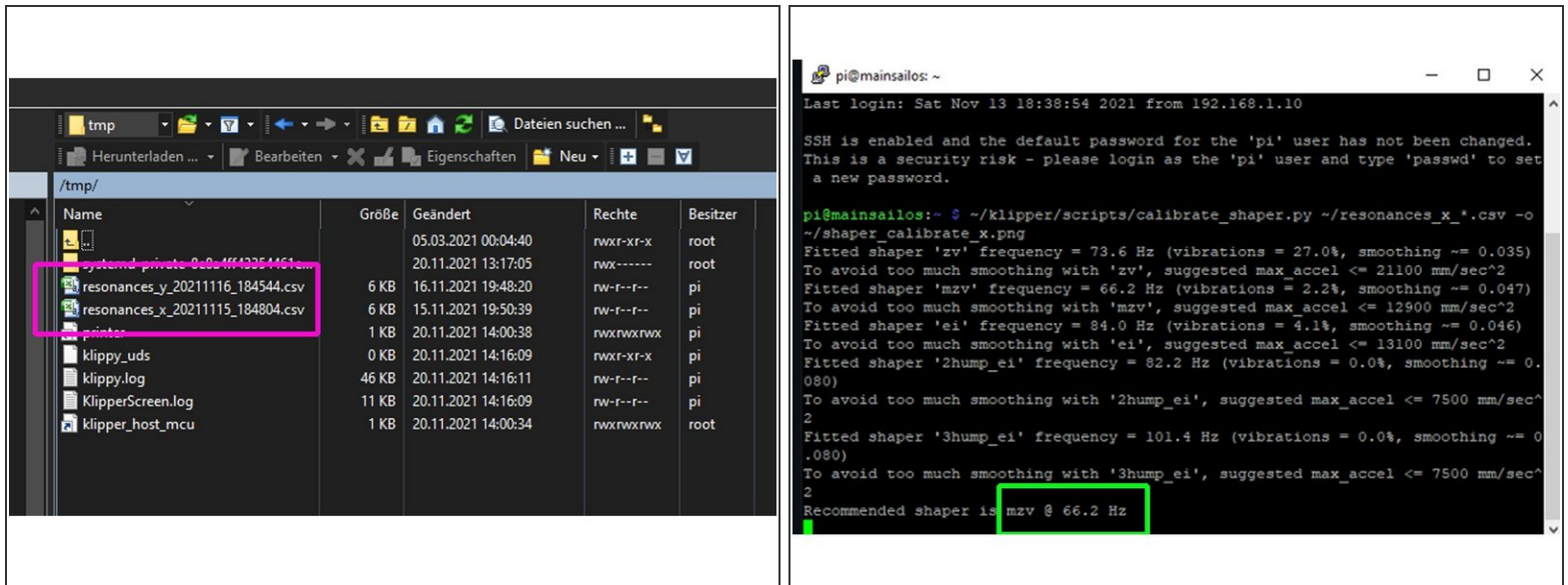
- A bracket for the ADXL345 module is not absolutely necessary for the measurement on the X axis. It can be fixed on the lid of the filament sensor with the M3 screw.
 - ⓘ Possibly. a slightly longer M3 screw must be used.
- Make sure that the X axis marking on the accelerometer is actually parallel to the X axis. The module must be well fixed!
- We use the printed bracket for the Y axis. First fix the module with two short M3 screws. For the second measurement, clamp the holder with module on the front of the pressure bed (see. Photo).

Step 8 — The resonance measurement on X and Y



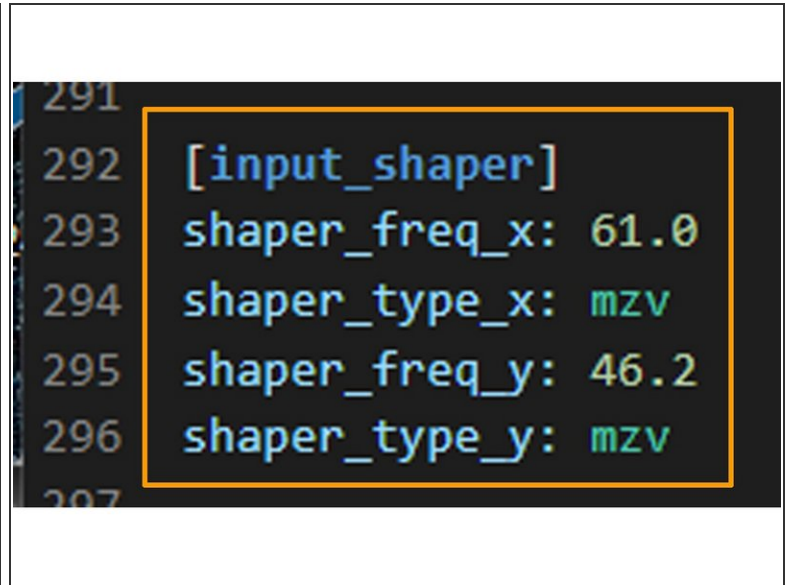
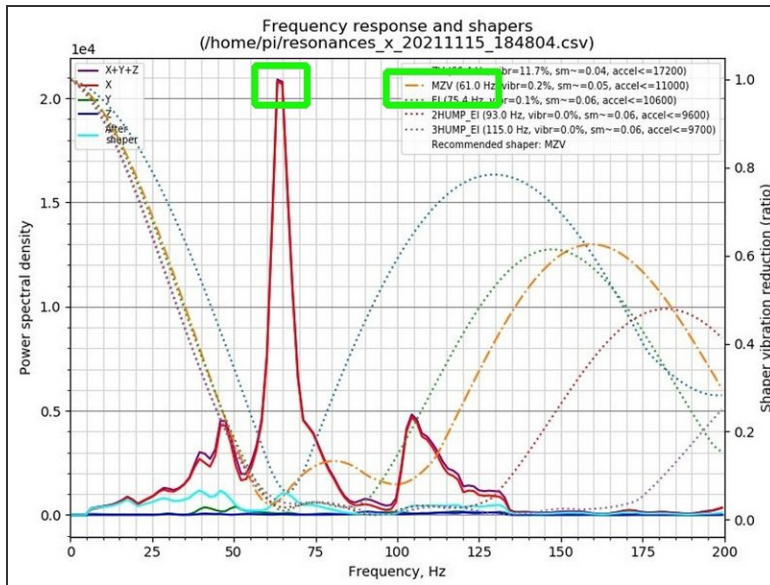
- First we test the function of the ADXL345. To do this, we open mainsail, enter in the console **ACCELEROMETER_QUERY** and go up **SEND**. Three values should now be displayed. If this is not the case, check the cabling again.
- If the test was successful, we can use it **TEST_RESONANCES AXIS = X** start our measurement for the X axis.
 - ⓘ The measurement takes a few minutes and it gets quite loud at times. Don't leave the printer unattended!!
- When the measurement of the X axis is finished, the ADXL345 module - as previously described - is mounted on the heating bed. We start the second measurement with **TEST_RESONANCES AXIS = Y**

Step 9 — Evaluation of the measurement



- We now open the Win SCP tool and navigate to the folder **tmp** in the main directory. There should now be two csv files.
- We copy these two files to our hard drive with WinSCP for safety reasons, because the folder **tmp** is deleted during the shutdown of the PI.
- We go back to the putty terminal and enter the following line: ~
/klipper/scripts/calibrate_shaper.py ~ /resonances_x_*.csv -o ~ /shaper_calibrate_x.png
 The script now performs a few calculations and ends up with a shaper type and frequency.
 - ⓘ Klipper supports several shapers. We usually recommend **MZV** or **EI**. Other shapers work more aggressively. Although more ringing is eliminated, edges are blurred or slightly printed.
- We proceed analogously for the Y axis. The input is: ~
/klipper/scripts/calibrate_shaper.py ~ /resonances_y_*.csv -o ~ /shaper_calibrate_y.png

Step 10 — Takeover of the shaper in printer.cfg



- If we now have the folder again in WinSCP tmp open, two graphics in the format *.png should have been added there.
- The graphics can be opened with Windows tools. The graphic evaluation for "X" is shown in the screenshot shown". The recommended shaper **MZV** correlates with the peak of the X curve.
 - ① The MZV shaper in the graphic shown differs somewhat from the shaper recommendation from step 9 (66.2Hz vs. 61.0Hz) because this is a different measurement with a different setup.
- We open in Mainsail under "Machine" **printer.cfg** and add the proposed shapers and frequencies **[input_shaper]** in our configuration and save it.
- We can now switch off the printer and the Pi, remove the ADXL345 module from the heating bed and remove the Dupont cables from the Pi. If something changes in the setup of the printer or the printer is moved, a new measurement should be made.

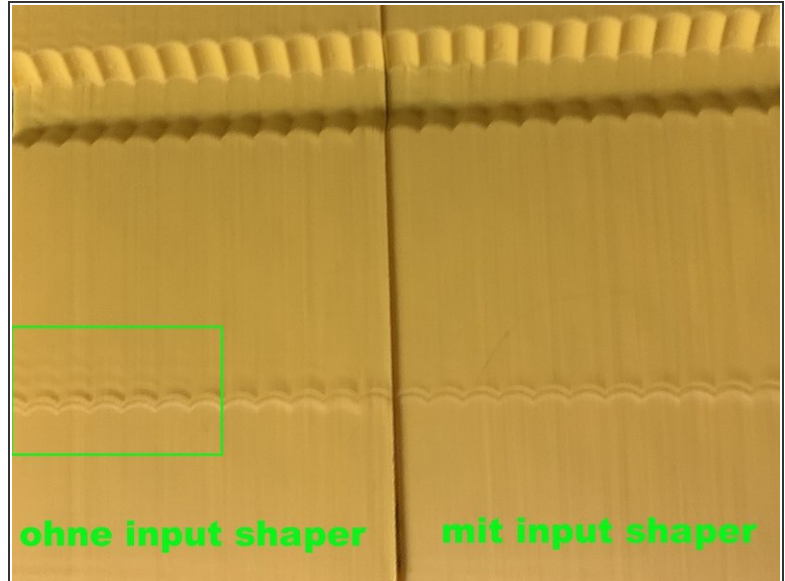
Step 11 — Test model printing

Tuning

Basic tuning requires measuring the ringing frequencies of the printer and adding a few parameters to `printer.cfg` file.

Slice the ringing test model, which can be found in `docs/prints/ringing_tower.stl`, in the slicer.

- Suggested layer height is 0.2 or 0.25 mm.
- Infill and top layers can be set to 0.
- Use 1-2 perimeters, or even better the smooth vase mode with 1-2 mm base.
- Use sufficiently high speed, around 80-100 mm/sec, for **external** perimeters.
- Make sure that the minimum layer time is **at most** 3 seconds.
- Make sure any "dynamic acceleration control" is disabled in the slicer.
- Do not turn the model. The model has X and Y marks at the back of the model. Note the unusual location of the marks vs. the axes of the printer - it is not a mistake. The marks can be used later in the tuning process as a reference, because they show which axis the measurements correspond to.



- Under <https://www.klipper3d.org/prints/ringing...> a test model for input shaper tuning can be downloaded. Note the slicer settings (s. Screenshot) and deactivate PA before printing by entering **SET_PRESSURE_ADVANCE ADVANCE = 0** in the mainsail console.
- The ringing is clearly visible on the left model (printed without shaper), on the right (with shaper) it looks much better in this regard :-)

Step 12

! Klippy-Status: shutdown

MCU 'rpi' error during config: Unable to open spi device

Once the underlying issue is corrected, use the

"FIRMWARE_RESTART" command to reset the firmware, reload the

config, and restart the host software.

Error configuring printer

↻ NEUSTART

↻ FIRMWARE NEUSTART

- Sometimes the error message shown comes. There is often a conflict here if e.g. Access the SPI interface of the touchscreen driver. Solution: We open via **sudo nano /boot/config.txt** the screen configuration, set in front **dtoverlay** a pound sign and save. After a reboot, the bug should be fixed.
- ① We do not need the display for the measurements. After the measurement has been carried out **dtoverlay** be reactivated.