Voron Design
SKR Mini E3 Setup Guide
V0.0

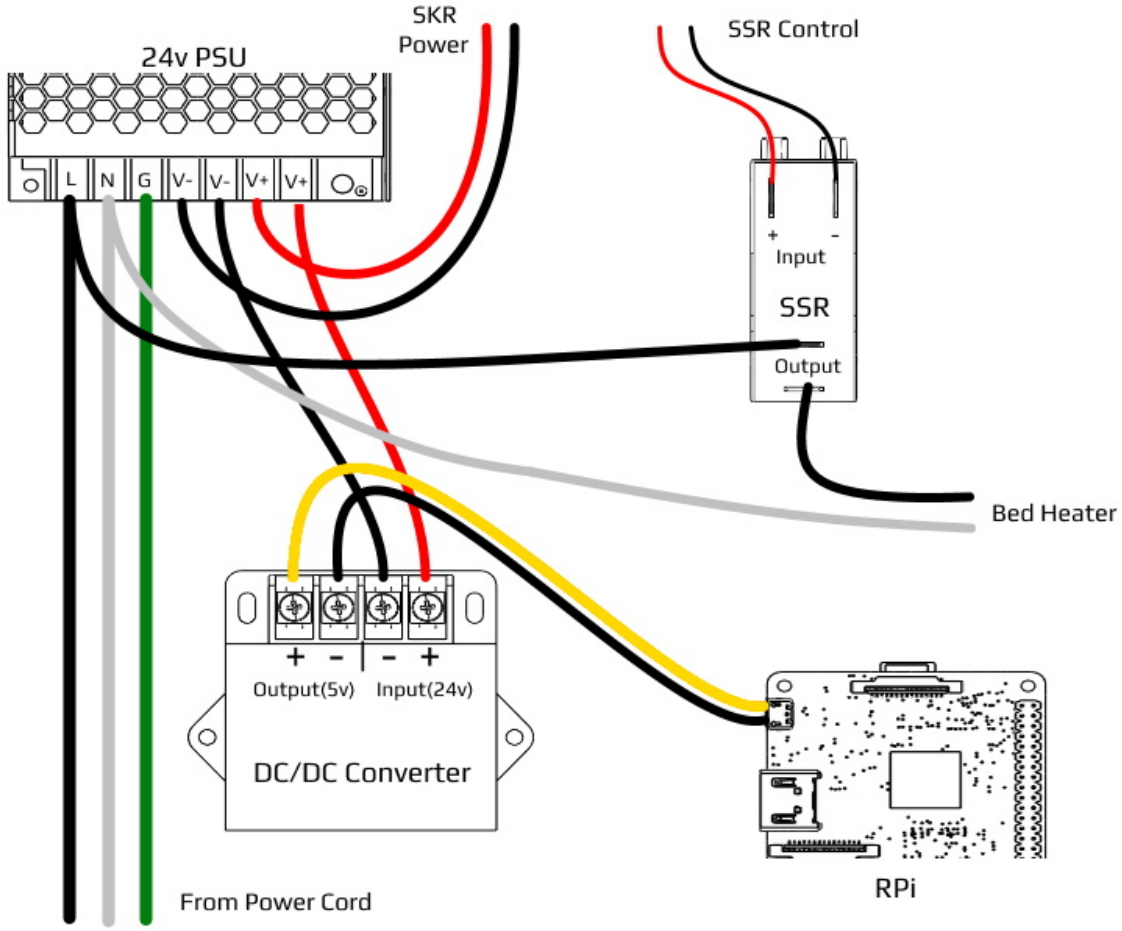
Power Supply Wiring

Safety Note

When wiring up your printer electronics, you will be working with high voltage wiring. Always double check to make sure that the printer is unplugged and any capacitors in your power supplies have discharged before touching any wire or terminal that may be live.

Damage Risk

Never plug or unplug any device (high or low voltage) while the the printer is powered. In addition to being a safety hazard, you will likely damage electronic components. Of particular note are stepper drivers which can easily be damaged by connecting or disconnecting stepper motors or drivers while powered.



SKR E3 Board Configuration

Jumper Configuration

- Make sure power jumper is between INT and +5V (should be default from factory). If this is not installed correctly you may have power issues with your Raspberry Pi which can cause throttling

Wire Terminals

SKR E3 boards use JST-XH terminals. This will mean that you will need to purchase a JST-XH connector kit with 2 pin, 3 pin, and 4 pin connectors. JST-XH terminals are keyed and will only fit in one orientation so pay close attention while crimping to make sure you do not make a mistake. You can carefully de-pin connectors with a dental pick, toothpick, or similar.

For wiring the stepper motors, keep the same wire color sequence that your stepper motors came with and make sure you use the same sequence for all of your stepper motors. If you have the spec motors from StepperOnline, the wires should in the the color order shown in the SKR E3 wiring diagrams on the following pages.

Note: Steppers should ship with a diagram that outlines wire pairs. You can also determine pairs by touching two wires together. If the stepper becomes more difficult to turn, then you have found a pair. These methods can be used if your wire colors are different or you mislabel wire order.

Important: If you find out your motors are going the wrong way once you start up your printer for the first time, you do not need to repin your connectors. You can invert the DIR (direction) pins in your configuration by adding or removing ! in front of pin and it will work properly.

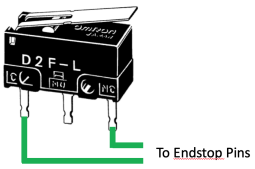
Endstop Wiring

There are two ways of wiring your endstops, one is NC (normally closed) and the other is NO (normally open). For normally closed configurations, the endstop switch allows current to flow through it when it is not triggered. For normally open configurations, the end stop switch only allows current to flow through it when it is triggered.

While both of these configurations will work fine in an ideal world, NC configurations are more robust because if a wire breaks or a terminal becomes disconnected, the printer will think that the end stop has triggered and the printer will stop movement before the toolhead crashes in to the frame or the bed.

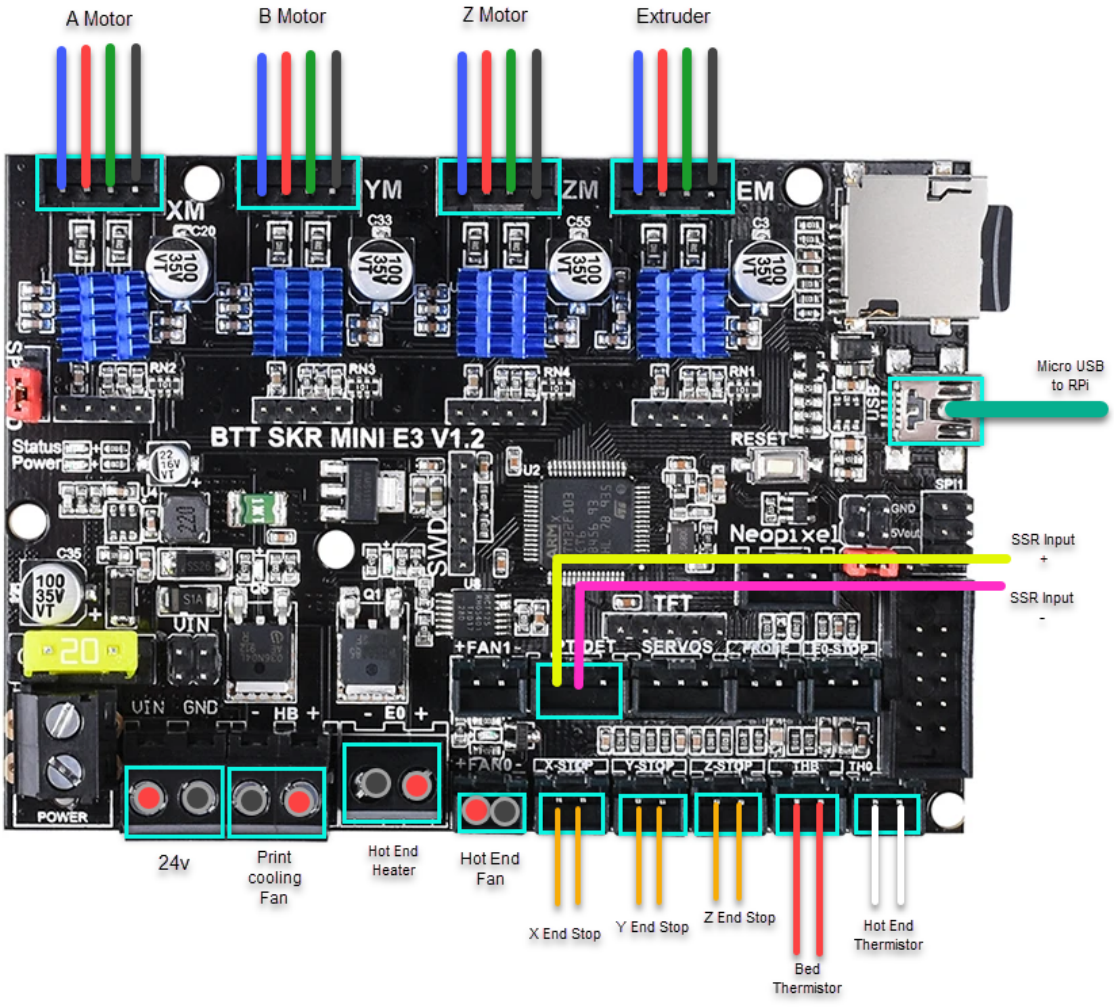
Wiring mechanical end stop switches for NC operation is easy, as they generally have three pins exposed. With a multimeter, probe each combination of the three pins until you find a pair that has continuity (0 ohm resistance) when the switch is not triggered,

but does not have continuity (infinite resistance) when the switch is triggered. The outer two pins are often the NC pins, but verify prior to installation.



MCU Wiring (X, Y, E, Hot End)

- Plug in stepper motors for X, Y, Z, and E in positions Xm, Ym, Zm, and Em
- Plug Hot End thermistor to thermistor TH0
- Plug Hot End heater in to E0
- Plug Hot End Fan in to FAN0
- Plug Print Cooling Fan in to HB
- Plug Bed Thermistor in to THB
- Connect SSR pins to PT-DET Connector
- Connect X end stop to X-STOP connector
- Connect Y end stop to Y-STOP connector
- Connect Z end stop to Z-STOP connector
- Wire 24V+ and V- from DC power supply to VIN and GND
- Connect USB Cable to your SKR E3, but do not connect it yet to your Raspberry Pi



Klipper Installation

References: Klipper Installation Instructions SKR Installation Instructions

Installing Klipper Firmware on your SKR Mini E3 Board

- Install OctoPi on your Raspberry Pi (guide here: https://octoprint.org/download/)
- Once it is installed, ssh in to your Raspberry Pi using PuTTY on Windows or the Terminal on macOS

    ssh pi@octopi OR ssh pi@192.168.1.X (Or whatever ip address your Raspberry Pi has)

- Enter password, the default one is “raspberry”. It is recommended to change this for security using
    sudo raspi-config
    Change the password via “Change User Password”

- Once you are at the command line of the Raspberry Pi, run the following commands:
    git clone https://github.com/KevinOConnor/klipper
    ./klipper/scripts/install-octopi.sh

- When the install script has completed, run the following commands:
    cd ~/klipper/
    make menuconfig

In this menu structure, you’ll want to pick a few things. Make sure your Micro-controller Architecture is XXXX, and your processor model is the STM32F103 with a 28KiB bootloader. Also select "enable extra low-level configuration options" and configure "GPIO pins to set at micro-controller startup" to "!PC13".
When your configuration matches the image below, select Exit and “Yes” if you are asked to save the configuration.
In the terminal window, type the following and pressing enter after each:

    make clean

    make

This command creates a firmware file **klipper.bin** that is stored in the folder /home/pi/klipper/out.
The file needs to be copied to your Mini E3 board. The easiest way to do this is to use a program like WinSCP (Windows) or Cyberduck (Mac) to copy the file to your computer via SFTP. See the image on the next page that shows SFTP via Cyberduck.

- Copy the **klipper.bin** file to your desktop, and rename the file **firmware.bin**

Make sure the SKR Mini E3 is not powered, and then remove the microSD card.

- Connect the microSD card to your computer and open it.

There will be a file named **firmware.cur** on it—you can delete that file or keep it there, it does not matter.

- Copy the **firmware.bin** file from your desktop to the microSD card. If you have trouble transferring files from your computer to the microSD card, reformat the microSD card with a FAT32 file system and then try again.

- Plug the microSD cards back in to your SKR E3 board
- Turn on your power supply to power up your SKR E3 boards

Important: If you do not power your SKR with 12-24V, Klipper will be unable to communicate with the TMC drivers via UART and it will automatically shut down.

Configuring Octoprint to use Klipper

Reference: KevinOConnor - klipper/docs/Installation.md
The OctoPrint web server needs to be configured to communicate with the Klipper host software.

Using a web browser, login to the OctoPrint web page and then configure the following items:

- Navigate to the Settings tab (the wrench icon at the top of the page)

- Under "Serial Connection" in "Additional serial ports" add "/tmp/printer" then click "Save"

- Open Settings tab and under "Serial Connection" change the "Serial Port" setting to "/tmp/printer"

- In the Settings tab, navigate to the "Behavior" sub-tab and select the "Cancel any ongoing prints but stay connected to the printer" option, then click “Save”

- From the main page, under the "Connection" section (at the top left of the page) make sure the "Serial Port" is set to "/tmp/printer" and click "Connect". (If "/tmp/printer" is not an available selection then try reloading the page)

- Once connected, navigate to the "Terminal" tab and type "status" (without the quotes) into the command entry box and click "Send". The terminal window will likely report there is an error opening the config file - that means OctoPrint is successfully communicating with Klipper.

Setting up Voron Printer Configuration File

- Download the Voron configuration file from the following link (or attached with this file):

  https://github.com/VoronDesign/VoronUsers/tree/master/firmware_configurations/klipper/eddie

- Using WinSCP, Cyberduck, Notepad++ NppFTP, or BBEdit, transfer the downloaded file to your raspberry pi in the following folder:
  ~/klipper/config/

- Run the following command to copy the Voron configuration into your printer config:
  cp ~/klipper/config/FILENAME_OF_VORON_CONFIG.cfg ~/printer.cfg

Note: There are many ways of editing your config file. Using the built-in Nano editor through SSH is simple, but it is not user friendly. Notepad++ with the NppFTP plugin (Windows) or bbEdit (MacOS) are better alternatives. Instructions on how to use them are in the appendix.

- Review the configuration file by typing:
  nano ~/printer.cfg

You'll notice that near the top of the file, there is a section titled [mcu] this section is where we define that we will be using the SKR E3 controller, and identifying the controller so that Klipper knows that components are connected to it. First of all, we need to identify what the Raspberry Pi calls the controller so we can correctly list it in the configuration.

- Take the USB cable from the SKR E3 and plug this in to one of the USB ports on your Raspberry Pi, then run the following command:
  ls -l /dev/serial/by-path/

You should see something similar to this:

- Copy the corresponding text from your terminal window **platform-3f980000.usb-usb-0:1.5:1.0** and paste it in a text file temporarily.

- Open your configuration file (nano ~/printer.cfg) and navigate to the [mcu] section. After the text “serial: /dev/serial/by-path/” paste your SKR path so that the line becomes:

    serial: /dev/serial/by-path/platform-3f980000.usb-usb-0:1.5:1.0

- Exit the text editor using CNTL-X, and save when asked.

- Under Octoprint’s Terminal tab type:
    FIRMWARE_RESTART and press enter send the command to restart Klipper.

NOTE: Pay close attention and complete the remaining configuration checks. If you do not complete these steps, your printer will not run!

1. Under [extruder] verify that your sensor_type is correct. Do not worry about step_distance and pid values for now, they will be updated later in the setup process.
2. Under [heater_bed], verify that your sensor type is correct.

Save the configuration file.

- Under Octoprint’s Terminal tab type:
    FIRMWARE_RESTART and press enter send the command to restart Klipper.

The terminal window should show a status “Ready”—if not, type “status” in to the terminal command and press enter. If Klipper says that it is not ready, it will generally notify you if there is a configuration issue that needs to be fixed.

Common Klipper Errors

TMC UART Error: This appears when the communication between the TMC drivers and the SKR is not working. Typically this means that you have not powered the SKR board with 12-24V (TMC drivers didn’t boot), you haven’t plugged in the TMC steppers to the correct spots, or you forgot to add or remove a jumper as detailed above.

ADC Error: ADC stands for “Analog to Digital Converter” and is what is used to convert thermistor readings to temperatures for your hotend and heated bed. As a safety precaution, if Klipper is expecting a thermistor to be plugged in but it is reading an invalid reading (no thermistor = open, or 0 ohms for a shorted wire as closed), it will go in to this shut down mode.

Unable to connect: Once the underlying issue is corrected, use the "FIRMWARE_RESTART" command to reset the firmware, reload the config, and restart the host software.

Check MCU IDs match your printer.cfg

"*Make sure you get the paths right"*

Klipper Troubleshooting

Retrieve Log File: The Klippy log file (/tmp/klippy.log) contains debugging information.
M112 command in the OctoPrint terminal window immediately after the undesirable event

There is a logextract.py script that may be useful when analyzing a micro-controller shutdown or similar problem.

```
mkdir work_directory
cd work_directory
cp /tmp/klippy.log .
~/klipper/scripts/logextract.py ./klippy.log
```

The script will extract the printer config file and MCU shutdown information to work_directory.

Klipper Configuration Checks

The moment you've been waiting for—your printer finally coming to life! Klipper has a very helpful configuration check guide that will help make sure that everything is operating properly. Please follow the steps detailed at the URL below:

https://github.com/KevinOConnor/klipper/blob/master/docs/Config_checks.md

Endstop Check

Make sure that none of the X, Y, or Z Endstops are being pressed, and then send a QUERY_ENDSTOPS command via the Octoprint command line. The terminal window should respond with the following:

```
Send: QUERY_ENDSTOPS
Recv: x:open y:open z:open
```

If any of them say "triggered" instead of "open", double check to make sure none of them are pressed. Next, manually press the X endstop, send the QUERY_ENDSTOPS command again, and make sure that the X endstop says "triggered" and the Y and Z endstops stay open. Repeat with the Y and Z endstops.

You may find that one of your Endstops has inverted logic (it displays "open" when it is pressed, and "triggered" when it is not). In this case, go to your printer's config file and add or remove the ! In front of the pin. For instance, if your X endstop was inverted, you would add a ! In front of your pin number as follows:

endstop_pin: P1.28 —> !P1.28

Stepper Motor Check

To verify that each stepper motor is operating correctly, send the following command:

STEPPER_BUZZ STEPPER=stepper_x

Run this again for each of the motors (stepper_y, stepper_z, extruder). the Z motor should go UP first then down. If the stepper motors do not move, check wiring for loose connectors.

XY Homing Check

It's time to start by homing X and Y! You'll want to be able to quickly stop your printer in case something goes wrong (ie, the tool head goes in the wrong direction). There are a few ways of doing this—one is to use the E-stop button on your display (if you have one installed). Test the button and see what happens—Klipper should shut down, but the Raspberry Pi and Octoprint will still be running, but disconnected from Klipper. Press "Connect" in the upper left corner of Klipper, and then in the Octoprint terminal window send a FIRMWARE_RESTART command to get your printer back up and running.

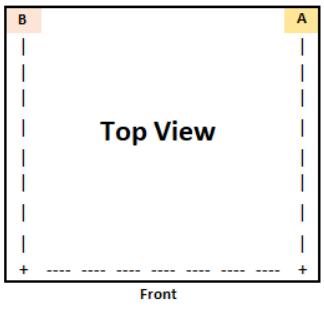
The alternative to this is to have your laptop right next to the printer with “restart” already in the terminal command line in Octoprint. When you start homing your printer, if it goes in the wrong direction—quickly send the restart command and it will stop the printer.

The final option is to power off the entire printer if something goes wrong.

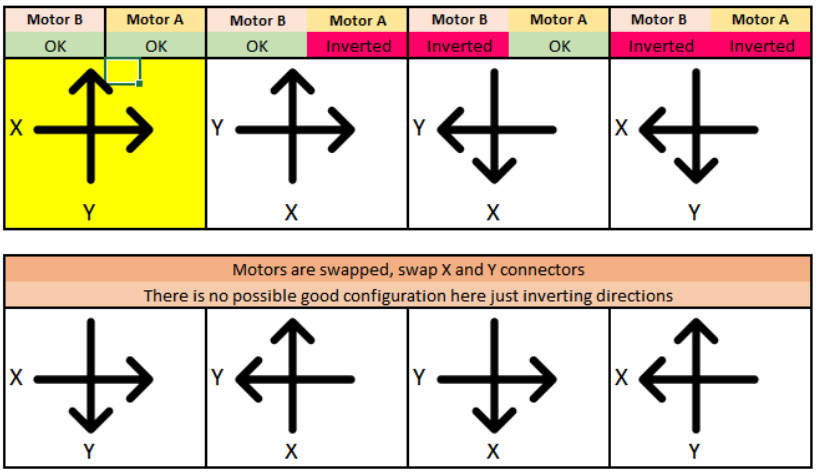
Now that you know how to stop the printer if something goes wrong, send a G28 X Y command to your printer. This will only home X and Y, not Z. The tool head should move to the right until it hits the X endstop, and then move to the back of the printer until it hits the Y endstop. In a CoreXY configuration, each motor has to move in order to get the toolhead to go in only an X or Y direction (think of an Etch a Sketch).

If the toolhead does not go in the correct direction, refer to the table below to figure out how to correct it. If you need to invert one of the motors, invert the direction pin (put a ! before the pin). If the motors are going in the directions that match the lower row, swap your X and Y connectors.

Visual Motor Configuration Guide



You can invert the direction of a motor by turning its connector 180 degrees or toggling the inverted flag (!) for the motor in the firmware. The arrows indicate the positive direction for move commands.



[stepper x] => Motor B
[stepper y] => Motor A

Define (0,0) Point

Home XY
Move the nozzle to the front left corner of the bed. Once you can get the nozzle close to the front left corner of the bed, send an M114 command. If X and Y are not ~0-5mm, update “position_max” and “position_endstop” for both [stepper_x] and [stepper_y]:

For X: New = Current – Get Position X Result

For Y: New = Current – Get Position Y Result

If you update anything in your configuration file, save the file and then restart Klipper using FIRMWARE_RESTART.

PID Tune Heated Bed

Move nozzle to the center of the bed and approximately 5-10mm above the bed surface, then run:

PID_CALIBRATE HEATER=heater_bed TARGET=100

It will perform a PID calibration routine that will last about 10 minutes. Once it is finished, type SAVE_CONFIG which will save the parameters into your configuration file.

PID Tune Hotend

Set the part cooling fans to 25% (M106 S64) and then run:

PID_CALIBRATE HEATER=extruder TARGET=245

It will perform a PID calibration routine that will last about 5 minutes. Once it is finished, type SAVE_CONFIG which will save the parameters into your configuration file.

Z Offset Adjustment

If you did not run PID tuning, set your extruder to 245C and heated bed to 100C and let the printer heat up for 15 minutes.

Run a G28, and then move the nozzle to the center of the bed

Run Z_ENDSTOP_CALIBRATE

Slowly move the nozzle toward the bed by using

    TESTZ Z=-1

Until the nozzle is relatively close to the bed, and then stepping down with

    TESTZ Z=-0.1

Until the nozzle touches a piece of paper on top of the build plate. If you go far down, you can move the nozzle back up with:

    TESTZ Z=0.1

Once you are satisfied with the nozzle height, type “ACCEPT” and then “SAVE_CONFIG”.

If you get an error (out of bounds), send Z_ENDSTOP_CALIBRATE, ACCEPT, and then SAVE_CONFIG. This will redefine the 0 bed height so you will be able to get closer.

you will need to re-run these Z offset adjustment steps after the completion of the bed leveling section as well.

Bed Leveling

The V0 uses manual bed leveling, the bed is small enough and thick enough that a mesh or other types of per print leveling are not needed. there is a Macro in Klipper to help with the manual bed leveling process

BED_SCREWS_ADJUST

This tool will move the printer's nozzle to each screw XY location and then move the nozzle to a Z=0.3 height. At this point one can use the "paper test" to adjust the bed screw directly under the nozzle. See the information described in "the paper test", but adjust the bed screw instead of commanding the nozzle to different heights. Adjust the bed screw until there is a small amount of friction when pushing the paper back and forth. this process will move all three mounting points of your bed closer to the nozzle so it is critical that you re-run the Z offset adjust after completing this section.

Once the screw is adjusted so that a small amount of friction is felt, run either the ACCEPT or ADJUSTED command. Use the ADJUSTED command if the bed screw needed an adjustment (typically anything more than about 1/8th of a turn of the screw). Use the ACCEPT command if no significant adjustment is necessary. Both commands will cause the tool to proceed to the next screw. (When an ADJUSTED command is used, the tool will schedule an additional cycle of bed screw adjustments; the tool completes successfully when all bed screws are verified to not require any significant adjustments.) One can use the ABORT command to exit the tool early.

After the BED_SCREWS_ADJUST command has been completed rerun the Z_ENDSTOP_CALIBRATE command to to bring your nozzle to the correct Z=0 position.

Extruder Calibration

Before your first print, you need to make sure that your extruder extrudes the correct amount of material. With the hotend at temperature, make a mark between your roll of filament and your extruder, 120mm away from the entrance to your extruder. In Octoprint, extrude 50mm 2 times (for a total of 100mm—Klipper doesn’t allow you to extrude more than 50mm at a time), then measure from the entrance of your extruder to the mark you made previously. In a perfect world, it would measure 20mm (120mm - 20mm = 100mm), but it usually won’t be. Take the value you have in your configuration file and update it using the following:

New Config Value = Old Config Value * (Actual Extruded Amount/Target Extruded Amount)

Note that a higher configuration value means that less filament is being extruded.

Paste the new value into your configuration file, restart Klipper, and try again. Once your extrusion amount is within 0.5% of the target value (ie, 99.5-100.5mm for a target 100mm of extruded filament), your extruder is calibrated!

Fine Tuning Z Height

As a reference, if you adjust the Z offset during a print using the Tune menu on your display, you can update your printer configuration with this new value. Remember that higher values for your Z_endstop_position mean that the nozzle will be closer to the bed.

New Position = Old Position - Tune Adjustment
New Position = Old Position - (-0.050) = Old Position + 0.050

Slicer Setup and First Print

Cura Installation

For your first print, use the latest version of Cura, but do not open it at first. Download the latest Voron Cura setup files pinned in #slicers_and_print_help, and then extract the zip folder into C:\Program Files\Ultimaker Cura X.X\resources.

Once that is complete, open Cura and under “non-networked printer” find the Voron tab and select the size of your printer. All the settings should be pre-populated for you.

First Print

Download the “voron_design_cube_v6.stl” from the Voron Github page (Voron-2/STLs/TEST_PRINTS), and open the file in Cura. Use the default slicer settings, but make sure the hotend temperature and bed temperature is correct for the filament you are using. A good starting point is 240C hotend temperature, 100C heated bed temperature, and 92% flow for ABS.

Slice the file and save the .gcode file to your desktop (if you haven’t set up the Octoprint Plugin). Navigate to Octoprint in your web browser, and upload the file to Octoprint. Press “Print” and closely watch the beginning of the print. If your nozzle is too far or close to the bed, on your printer display press the knob, navigate to “Tune”, and adjust the Z offset distance (+ is further from the bed, - is closer).

Once you are printing (with your printer fully assembled), take a quick video, upload it to the Voron subreddit and eat a well deserved bowl of cereal!

Appendix

Appendix 1 - Notepad++ Configuration Editing (Windows)

1. Install Notepad++ from: https://notepad-plus-plus.org
2. Under the “Plugins” tab, select “Plugins Admin”
3. Search for “NppFTP”, select the check box, and click “Install”
4. Restart Notepad++ if necessary
5. On the right, there will be a new section. Click the gear icon and select “Profile Settings”
6. In the bottom left, select “Add New” and name the profile as you wish
7. In the Hostname dialog, enter the IP address of your Raspberry Pi
8. In Connection Type, select SFTP
9. Port: 22
10. Username: pi
11. Password: *** (default is raspberry)

12. Close the dialog box, select the blue symbol, and select the name of the profile you created
13. Notepad++ will connect to your Raspberry Pi and display the file structure
14. Navigate to /home/pi and open printer.cfg
15. Make any applicable edits and then save the file

Remember to restart klipper from the Octoprint terminal to see your changes take affect!

Appendix 2 - bbEdit Configuration Editing (macOS)

1. Install bbEdit. The free version works great! https://www.barebones.com/products/bbedit/
2. Under File, select Open from FTP/SFTP Server…"
3. Under Server, type in your Raspberry Pi's IP address (will be different)
4. Select SFTP
5. Enter "pi" as the user
6. Enter your password, it will be "raspberry" unless you changed it.
7. Select Continue

8. Find "printer.cfg" in the file browser and double click to open the file
9. Make any necessary edits and save the file

Remember to restart klipper from the Octoprint terminal to see your changes take affect!

Appendix 3 - Recommended Octoprint Plugins

- OctoKlipper
- Themeify
- TerminalCommands
- Bed Level Visualizer
- Print Time Genius

Appendix 5 - Other Accessories

To add LED lights inside the enclosure, wire up the (+) side of the LEDs to a power supply that matches the LED rated voltage, and the (-) side of the LEDs to one of the H-Bed (Heated Bed) connectors on either MCU. Define this output in your klipper configuration file and install an Octoprint plugin to control these LEDs.

Appendix 6 - Contributors

- eddie V2.058
- nemgrea V2.199