

# Set up and initial calibration of a 3d printer

## Tighten Screws

It's a good idea to tighten up the screws, nuts, and bolts around your Ender 3 since they can come loose from the constant vibrations emitting from the machine.

Some Ender 3's can have loose bolts from delivery, so if you've never checked them all, it's a good idea to go around the 3D printer and check them out.

You can take the tools that came with your Ender 3 and tighten up these fasteners around the 3D printer. Try not to tighten them up too much though, just a nice secure level.

Try to make this a maintenance routine every 3-6 months or so. Having these loose fasteners can contribute to a louder 3D printer and lesser quality or accuracy.

## Adjust Belt Tension

Proper belt tension is important because if you print with loosely tensioned belts, you can get issues like layer shifting and ghosting while the overall print quality and dimensional accuracy can also be affected.

For Ender 3 and Ender 3 Pro, belt tension can be calibrated in the same way:

1. Loosen the two screws on the left at the end of the X axis bracket
2. Create tension by pulling the bracket to the right, or using another object to pull on it, and screw in the two screws while tension is being held.
3. Do the same for the Y axis, but with two screws on each side of the 3D printer.

Here is a video by "Ender 3 Tutorials" about tightening belts on Ender 3, Ender 3 Pro, and Ender 3 Max.

For Ender 3 V2, the process is a lot easier. This model comes with built-in XY axis tensioners which you can easily twist to tighten the belts.

## Check Eccentric Nuts

Tightening eccentric nuts is one of the things that are missed by many 3D printer hobbyists, but it is important to have them adjusted properly. These nuts are situated where there are wheels that move the axes such as the X axis carriage and Y axis carriage under the print bed.

You can easily tighten them by turning the nuts clockwise using the wrench that comes with the Ender 3 printer.

You should tighten them to the extent that they prevent the tilting or rotation of the print bed but make sure that they are not too tight as this can cause binding and printing issues.

It is better to lose all eccentric nuts and then give a turn (1-2 at a time) to each nut one by one. This will ensure that all nuts are tightened evenly and there is no tilt in the X carriage.

A user also experienced a wobbling bed while printing. Tightening the eccentric nuts resolved all these issues for them. Many users said it fixes different types of issues they were having, like another user who said their 3D printer would print oblong circles since the eccentric nuts were too tight.

## Adjust Bed Level

Here's how to calibrate your Ender 3's bed level:

1. Pre-heat your bed and nozzle to normal printing temperatures (50°C bed and 200°C nozzle)
2. Click "Home" on the Ender 3 display screen and it will take all axes to their home or zero positions.
3. Click on the "Disable Steppers".
4. Bring the printhead to one corner of the bed just above the levelling screw and place a piece of paper in between the nozzle and the print bed.
5. Adjust the bed levelling knobs to move the bed up until it touches the paper. It should have tension but still be able to move a little
6. Repeat step 5 on all corners and the centre of the print bed.
7. Once all corners have been calibrated, do a second round of this to ensure a good bed level.

8. You can then do a level test and do "live levelling" which is when you adjust the bed levelling knobs as the test is being printed to get the perfect bed level.

## Check Bowden Tube

Check the fit of the Bowden tube where it connects to the extruder. Ensure that it is pushed fully home and that there is no movement of the tube when pulled on lightly.

At the hot end it is important that the Bowden tube is in contact with the print nozzle. If the printer has been used remove the filament and disconnect the Bowden tube. Do a hot/cold pull to clear any blockage and use the needle tool to clear the nozzle. Unscrew the nozzle approx 1/3 of a turn. Check that the bowden tube is clear and cut square at the end, then push the Bowden tube down into the fitting until it touches the nozzle. Ensure the Bowden tube is tight and then retighten the nozzle. This ensure that the nozzle and Bowden tube are in contact.

## Calibrate Extruder Steps

**It is best to confirm that your filament diameter is accurate, and check that your filament is of good quality without absorbing too much moisture before you calibrate the extruder steps and your flow rate.**

To calibrate the extruder steps on Ender 3, extrude a certain amount of filament through the control screen, then measure it to see if it extruded the right amount, or more/less. The difference between the set value and measured value can be used to calculate the correct E-steps value for your Ender 3.

Calibrating your extruder steps is essential to 3D print models to a good standard. If you don't calibrate your extruder steps and they aren't set properly, you can experience under or over extrusion.

Here's how you calibrate the extruder steps on an Ender 3:

- Start by measuring your filament from its endpoint to 100mm length and put a mark there using a permanent marker.

- Measure 10mm more above the 100mm point and put another mark as it will be an indication for you to measure the difference and find the correct E-Steps.
- On Ender 3, navigate through "Prepare > "Move Axis" > "Move 1mm" > "Extruder" and keep on turning the knob clockwise under the screen until you reach the 100mm value.
- Wait for your hot end to reach the minimum temperature required for the extruder to start working, normally it is around 200°C for PLA
- Let the 3D printer extrude the filament and once it's done, look out for the mark.

If the 100mm mark on the filament is right at the extruder, you are good to go as the extruder is perfectly calibrated.

If the mark is still there, it means that your Ender 3 is under extruding and if the 100mm mark is not visible, it is over extruding.

Suppose there is still 8mm filament left before 100mm, your 3D printer is extruding "100 – 8 = 92mm of filament.

In case the 100mm mark is gone, measure the amount of filament left before the 110mm mark. Suppose there is 6mm left before the 110mm mark, your Ender 3 is extruding "110 – 6 = 104mm".

1. Go to "Control" > "Motion" > "E-Steps/mm" to know the current set value of extruder e-steps.
2. Suppose the default e-steps on Ender 3 is 95steps/mm. Now put values in the formula:
  - (Desired Amount of Filament \* Current Value of E-Steps) / Filament Extruded.

For under extrusion:

- $(100\text{mm} * 95\text{mm}) / 92\text{mm} = \text{Correct e-steps}$
- $9500/92 = 103\text{steps/mm}$
- 103steps/mm is the new and correct E-Steps value of your Ender 3.

For over extrusion:

- $(100\text{mm} * 95\text{mm}) / 104\text{mm} = \text{Correct e-steps}$
- $9500/104 = 91\text{steps/mm}$

- 91steps/mm is the new and correct E-Steps value of your Ender 3.
1. Go to "Control" > "Motion" > "E-Steps/mm" again and put the new value of E-Steps and start printing.

Some people talk about calibrating the E-Steps at the end of the extruder without a nozzle. However, a user said that he likes to calibrate e-steps with the method mentioned above as it includes the nozzle as well.

Doing so reduces the chances of facing future issues because sometimes extruders work great without any additional load, but once you attach a nozzle and the extruder has to push filament through it, the issues can occur. Partial clogging in the hotend can also affect your e-steps measurements.

## **XYZ Steps – Calibration Cube**

To calibrate the XYZ steps of an Ender 3 you can 3D print a 20mm XYZ Calibration Cube. Just print the cube and measure it from all axes using digital calipers. If all axes measure exactly 20mm, well and good, but if there is a difference even in fractions, you need to calibrate the XYZ steps.

To calibrate the XYZ steps, you need to download the XYZ calibration cube from Thingiverse. The X, Y, and Z letters indicate each specific axis which makes it easy for you to conclude which axis needs calibration and which axis is accurately calibrated.

- After you have downloaded the XYZ Calibration Cube from Thingiverse, simply start printing. You should not add any supports or rafts as they are not required and can ruin measurements.
- Once the print is finished, get some digital calipers and measure the cube from all angles, one by one.
- If the measured value for each angle is 20mm, you are good to go but even if there is a small difference, you need to calibrate the XYZ steps.
- Before moving forward, Go to the "Control" > "Parameters" to know the current steps/mm being used by your Ender 3. If you are unable to find the value, connect your Ender 3 printer to the computer having software such as Pronterface, etc. Send a G-Code command G503 through a compatible software and you will receive a string having the steps/mm values.

Suppose the X-axis of the cube has a measurement of 20.13mm and the current steps/mm value in Ender 3 is X150. Put values in the formula to get the right value of steps/mm for the X-axis.

- $(\text{Standard Values} / \text{Measured Value}) * \text{Current Value of Steps/mm} = \text{Correct Value for Steps/mm}$
- $(20\text{mm} / 20.13\text{mm}) * 150 = \text{Correct Value for Steps/mm}$
- $0.9935 * 150 = 149.03$

So, 149.03 is the new and correct steps/mm value for the X-axis of your Ender 3.

1. Put the correct value into your Ender 3 using the software or through the control screen if you have the firmware that can adjust it.
2. Print the XYZ calibration cube one more to see if the new value worked to get the 20mm dimensions.

Adjusting XYZ steps just based on ne printed model's dimensions is not a good idea as it can affect the calibrations. Printing the cube multiple times and checking the difference is recommended.

## Temperatures

Print a temperature tower for each different roll of filament to assist in setting the best temperatures. It will be different for each brand and could be different for each roll.

## Drying and storing filament

Ensuring that your filament is dry is very important to get good results. Filament that has absorbed moisture will cause a long list of problems.

At the very least filament should be stored in a sealed bag along with plenty of silica and dried regularly or at the first sign of print failures.

Designated filament driers can be found on the internet, alternately a suitably modified food dehydrator can be used.

# Modifications

The list of modifications available for hobbyist 3d printers is a long one. Keep in mind that the word modification does not necessarily mean an improvement.

Many of the modifications are simply visual, such as coloured stipes or end caps and offer no improvement in the way the printer performs. Others like cable clips and screen back covers tidy up and protect various elements of the printer. Of course, some modifications can offer significant improvements to your printer but they often come with issues from incorrect installation and setting up. Know your printer and do plenty of research before going down this route.

Beware of the hype. For everyone that thinks a direct extruder is better, you will find someone who gets by perfectly well with the stock system. This goes for other things too, dual Z drive, extra cooling fans ETC.

Before committing to modifications get used to how your stock printer works, learn how to spot wet filament, under extrusion and blockages, loose carriages and bed level issues. This information will serve you well in the future.

If you do decide to modify your printer, do one modification at a time and get it working correctly. Doing multiple modifications, such as replacing the mother board, installing BL Touch and dual Z drive all at the same time is a recipe for disaster.