

**Ideally** you would do most of these steps for every print or every individual roll of filament. If you use a single brand you could setup profiles for each material, if you use a single brand and single material you could do this once. You should do this for every spool of filament or every print.

**Step 1: Calibrate your extruder (This only needs to be done when something changes)**

- Disconnect your hotend from the extruder.
- Cut the filament flush with whatever fitting you have.
- Using whatever interface you use to control your printer extrude 100mm/10cm of filament.
  - Your firmware may have a safety temperature preventing cold extrusion. If this is the case you will have to bring your hotend up to temp in order to extrude filament.
- Cut the filament and repeat this procedure two more times.
- Measure the three pieces of filament.
- Get an average (add the three measurements and divide by 300).
- If your average is not close to 100 you need to change your extruder steps per mm. Take the current steps per mm and divide it by (your average/100).
- Repeat until you are happy.

**Step 2: Calibrate your filament diameter, do this every print!**

Using a caliper, measure your filament diameter at several locations. Average out the measurements, **at least 3**, and enter that into your slicer under filament diameter.

**Step 3: calibrate your z height and first layer. Do this whenever something changes in your printer.**

- Print a single layer (of say a 20\*20mm cube) with your first layer at 100% height and width.
- Using a caliper measure the print in several places (at least 8) and adjust your bed or gcode z offset.
- Repeat until you are happy.

**Step 4: calibrate your extrusion multiplier!**

**Do this every print, to be a little lazy every roll, to be really lazy every brand and material, if your slacker only once**

- Print out a cube
  - (20mmx20mm would be nice)
  - in vase mode (single outline, no infill, no top or bottom layers)
  - set your extrusion multiplier to 1
  - set your extrusion width to equal the width of your nozzle.
- Measure the walls with a caliper in several places (at least 8) and get an average.
- Change your extrusion multiplier: new multiplier = old multiplier x (extrusion width / average measurement)
- Repeat until you are happy.

**Step 4.5: PID tune your bed and hotend.**

Before and after you calibrate temperatures and any time you change a fan or move something or a season changes. PID tune your hotend and bed to keep your temperature fluctuations to a minimum.

- M303 E(Extruder 0 for hotend 1 for bed) C(# of cycles 3-8) S(Desired Temperature)
- M303 E0 C5 S180 = PLA Hotend tune for 5 cycles

**Step 5: calibrate your temperatures.**

Do this for every different filament (color, brand, material, etc)

- Grab a temperature calibration tower off thingiverse: <https://www.github.com/sthopeness/>
- Set the temperature range to the range listed on your filament or by the manufacturer.
- Print the calibration tower and choose the best temp.

**Step 6: Calibrate your fan speed.**

(I have a Delta with three really powerful layer fans. If they all three run at 100% the hotend loses temp)

- Print your calibration tower again but change the fan speed vs the extruder temp.
- Choose the best fan speed for the finish you desire.

**Step 6.5: PID tune your hotend again with the layer fan set to the ideal speed!**