

E steps and flow rate tuning

E step calculation

What is an E step? This is the description of how many times the stepper motor on the extruder must advance for 100mm of filament to be advanced. There are two methods that can be used. First method is to remove the Bowden tube from the extruder. We will call this the free air method. The second would be to do the test thru the heated extruder. The test through the extruder is done by marking the filament at 100 and 120 mm from the inlet to the extruder.

Then use the controller or gcode to advance 100mm of filament. Once done, you measure the distance from the extruder to the 20mm mark to determine actual length advanced. You then use the actual filament extruded in a formula, along with the current e step to calculate your new E step value. Example using 87 mm advanced (100 commanded measured 33mm from the 120mm mark, giving 87 actual distance traveled) and 98 for current e step;

Formula $100/87 = 1.1494 \times 98 = 112.64$ so rounded off that's a new e step of 113 steps.

Using the free air method, we will remove the Bowden tube and coupler from the extruder.

Run the filament just out of the extruder by hand and use flush cuts to cut it at face of extruder. Now use the control panel to advance 100mm with hot end at temperature, as extruder will not function when nozzle off. Or use this gcode put into a text editor and saved as a gcode file extension for use in the printer. Note if you use abl use your start g28/g29 in place of what's provided here.

100mm gcode advancement program

G28 X0 Y0 Z0 – HOME ALL AXIS

G90 – ABSOLUTE POSITIONING

G92 E0 – SET EXTRUDER TO ZERO VALUE

M92 E93 - ***SET NEW E STEP *** (93 is factory value) (set new target value here once you have calculated your new e-step, to run a test of the new value)

M190 S60

M104 S215

M109

M82

G01 E100 F200; ADVANCE 100MM OF FILAMENT (***set to F50 if using the thru the hot end method****)

M140 S0

M104 S0

G90 E0; Return to absolute positioning

After extrusion stops, cut the filament in same location. Take the cut piece and measure its length. Use $100/\text{measured length} \times \text{the current e step}$ to calculate your new e step.

Example; we sent 100mm with an e step of 93mm the stock ender 3 value. Our cut length of material was 86mm. So $100 / 86$ is 1.1628 x93 equals a new e step of 108.13 or 108.

Ideology of each method. Free air is giving a direct linear advance without the restriction of the hot end flow path. The slicer is designed to use linear value along with measured diameter to calculate extruded volume in a part tool path. This method does not require you to calculate e steps again if changing filament type. It is one and done, only to be revisited if changing extruder or extruder drive gear. With this method any filament used will then be tuned with the flow rate to optimal extrusion using a single wall test cube. Print the cube at 0.40 single wall, then measure and record 2 values from all 4 sides. Add them together and divide by eight. Divide 0.40 by the resultant, and multiply that by 100 to give your new flow rate or extrusion multiplier. Example test cube measurements avg to be .428 so we take $0.4/.428$ which equals $0.934579 \times 100 = 93.458$ or 93% flow rate as your new value. Note: if you had already been using a flow rate modifier, you would be at that % of the rate you were using.

Example was at 97% and the calculation comes to 92%. That's 92% of 97% or 89% $97 \times .92$ is 89

In summary, the author prefers this method, as I never have to chase my e step, I can mark a filament of any type with its flow % on the spools label, and just change it in slicer. Being able to move through many materials at will.

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Ideology of threw the nozzle method. When done with a given filament, the flow rate may be left at 100% as you have tuned the e step to the current condition of the hot end and the specific filament that you are running. There is no need for a flow test to be done once the e-step is set, unless conditions change.