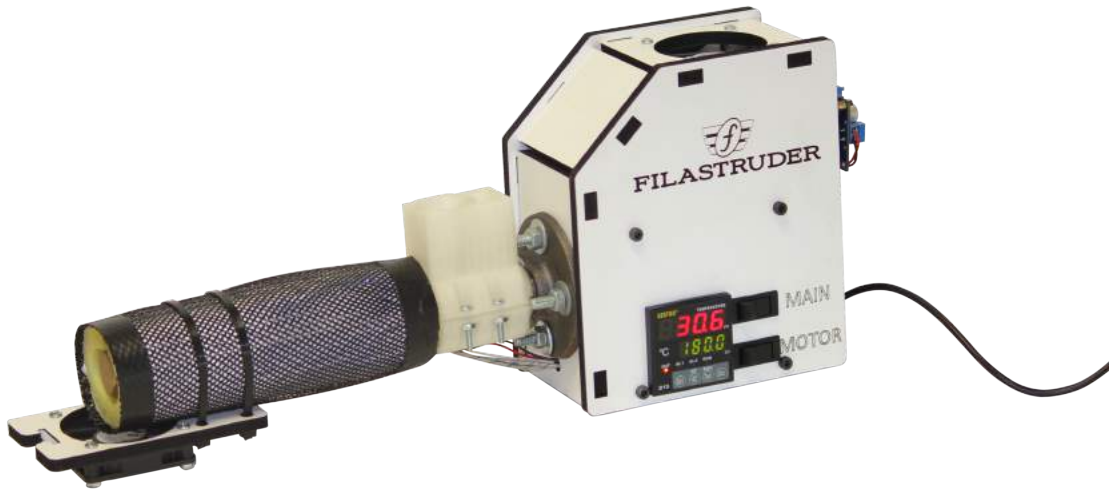


Instruction and Assembly Manual for Filastruder



Written by Tim Elmore
Contact: filastruder@gmail.com
Extruder Version: 2.0
Instructions Version: 2.0c

Cautions and Warnings:

The Filastruder can reach very high temperatures (>200C), high pressures (>150psi), and high torque. Exercise caution, including safety glasses, gloves, and not putting your fingers or other body parts where they may get caught in the rotating apparatus.

Some polymers can undergo thermal decomposition resulting in potentially toxic fumes. **Always use the Filastruder in a well ventilated area (*not your bedroom or inside your house*), and understand the thermal decomposition properties of the polymer you are extruding. It is recommended that you use a smoke detector, and/or a carbon monoxide detector.**

The Filastruder is a first-generation, experimental piece of hardware. Treat it as such. It is not a toaster or microwave. **Do not leave the house or go to sleep with it running. Be sure to check in on it periodically.** Basically, use common sense. If you have a question, post about it on the forum (where you downloaded this documentation from).

NOTE: Please be sure to read the stall protection section carefully. Failure to use the stall protection circuit properly may result in damage to the motor, gearbox, barrel, and/or auger. The USB port on the stall protection board does not output normal USB voltages, do not attempt to connect USB devices.

First things first: Check that all parts made the trip and are present.

Included Parts - Mechanical: bag

- 8 inch barrel/flange assembly
- Pipe coupling
- Shaft collar
- Thrust bearing
- Hex socket
- Grey PVC washer
- (4) ¼"-20 1.5" bolts
- (4) ¼" hex nuts
- (4) ¼" washers
- (4) M5-.80x40 motor mount bolts
- (4) M5-.80x100 enclosure bolts
- (4) M5 nuts
- (2) M3x35 Stall protection board bolts
- (12) 6-32 7/8" length screws
- (12) 6-32 nuts
- Filament guide (PTFE tube)
- 6 Regular zip ties (2 long, 4 short)

Included Parts – Electrical bag:

- Thermocouple (K-type)
- (2) 60mm fans, 12volt
- 5 female spade terminals
- 2 rocker switches
- Heater band
- (2) grommets
- (4) wire splices
- (4) pieces of heatshrink (or one long one)

Other Items Not Bagged

- Insulation w/ black sleeving
- Auger/feed screw
- Lasercut enclosure (remove masking tape protection)
- Aluminum chassis
- 12v power supply
- Stall protection board
- 12v gearmotor
- Temperature PID controller

- Brass plug/nozzle

User provided parts:

- Hopper (.STL file provided on support website: <http://www.soliforum.com/topic/2036/filastruder-documentation-and-cadstl-files/>)

Assembly Instructions:

If you need to drill a nozzle (brass plug):

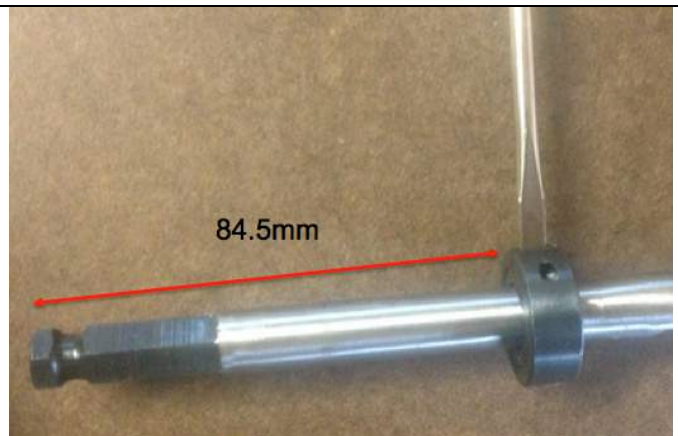
- a. 1/16" for 1.75mm, 7/64" for 3.0mm all the way through,
- b. 1/8" to a depth of 3/16"
- c. 1/16" diameter hole 3/16" deep in one of the flats for the thermocouple

Kit -> Extruder (mechanical) (ET: 1 hr)

Tools needed:

- Hex key set
- Pliers
- Wire cutters/strippers/crimpers
- Phillips and flathead screwdrivers

- 1.) Remove clamping screw from shaft collar. Slide collar onto the auger/feed screw to the point that there is 84.5mm from face of the collar to edge of the feed screw. It may help to open the collar a bit by lightly tapping a flathead screwdriver into the gap the clamping screw goes through. Tighten clamping screw using a (SAE) allen key.
- 2.) Install the black rubber grommets from the electrical bag into the bottom two holes on the aluminum box chassis. These protect the wires from chafing on the metal edges.



- 3.) Slide thrust bearing onto feed screw. This is composed of the cage and two races, in a green box and green bags, respectively. It is a good idea to lubricate the bearing with light oil or grease. This is primarily to prevent corrosion.
- 4.) Slide gray washer onto feed screw.
- 5.) Slide feed screw into pipe nipple/barrel/flange assembly. **Check that feed screw can be rotated freely by hand.**
- 6.) Lay out 4 main bolts, put them through the metal chassis with the heads of the bolts on the inside of the chassis.
- 7.) Slide 2 lasercut circular spacers onto each bolt, then slide on the lasercut wooden plate, then slide on the barrel/flange assembly.
- 8.) Put a washer and nut on each bolt. Tighten by hand.
- 9.) Note: Axial movement of 1-2cm is normal. Slide the auger so that the



(only one bolt/spacer set shown for clarity's sake)

thrust bearing is compressed during the future assembly steps. You can also lay on back with auger pointing upwards, so gravity compresses the bearing. Pressurized plastic will handle the compression in operation. **Check that roughly 5mm of the feed screw sticks out of the barrel with the thrust bearing compressed.**




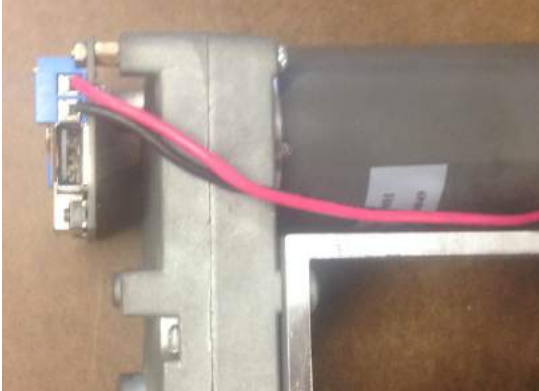
- 10.) Slide the hex socket onto the motor shaft.
- 11.) Attach motor to the chassis using provided bolts.
- 12.) While pushing the auger towards the motor with one hand, check that the hex socket coupling the motor to the auger can slide back and forth a 1-2mm. The purpose of this check is to ensure that the thrust bearing, not the motor, is handling all of the axial force produced by the pressurized plastic. If you find this not to be the case, feel free to contact support.



- 13.) Thread coupling onto nipple.
- 14.) Thread brass plug/nozzle into coupling.



Mechanical assembly is complete, now prepare for electrical assembly. Once you are ready to install the hopper, ensure that it is mounted with the soda bottle threads towards the nozzle, away from the motor, like the photo on the first page of this PDF.

<p>1.) Install heating band on coupling. Wrap hotend with provided insulation. Provided insulation is a bit intentionally undersized to provide a tight wrapping. Form it to the shape of the heaterband by squeezing it around the heater/coupling. Secure with sticky section of paper wrapping. Edge of insulation should be even with the face of the nozzle. Insulation not shown. Black mesh sleeving is provided to go over the insulation, but it is for cosmetic reasons only.</p>	
<p>2.) Install stall protection board using provided hardware: M3 screws in large mechanical bag, M3 standoffs and nuts with stall protection board.</p>	

Kit → extruder (electrical) (ET: 30 mins)

- 1.) Insert PID controller and switches into Laser cut wood face – **Note:** If you wish to use the PID controller’s white bracket, you will need to trim the plastic retaining clips to fit in between switches and controller housing.
- 2.) Cut the 12v cable coming out of the power supply approximately 12 inches away from the power supply. The 12v cable is the one that does not plug into the wall.
- 3.) Use some of the cable you just cut off to extend both the heater wires and the extruder fan’s wires, 8 inches each. Use the included ferrules and heatshrink for this.
- 4.) Connect wiring as shown in schematic (Figure 2). Use remaining wire from Step 2/3 to provide power to the stall protection board, the jumper providing power to the second switch, and the jumper from terminal 8 to 9 on the controller. Note that some power supplies have nonstandard wire colors – e.g. brown (+) / blue (-), always confirm polarity with a meter. On the wiring diagram, red represents positive and black represents negative. The motor should turn clockwise as viewed from the hotend.
- 5.) Insert thermocouple into hole on hex flat of nozzle.. Secure with kapton tape, metal zip tie, or pipe clamp. Connect the thermocouple to the controller by sliding it under the screws. Observe polarity.
- 6.) **Inspect all wiring for stray strands, loose connections, etc. If you are uncertain, upload pictures to the forum, or have a knowledgeable friend check it out!**
- 7.) Plug the Filastruder into an outlet. Check that one of the switches turns on the PID controller/heater, and the other turns on the motor/fan. fans. The motor should turn clockwise as viewed from the hotend. Turn both switches off, proceed to operation instructions.

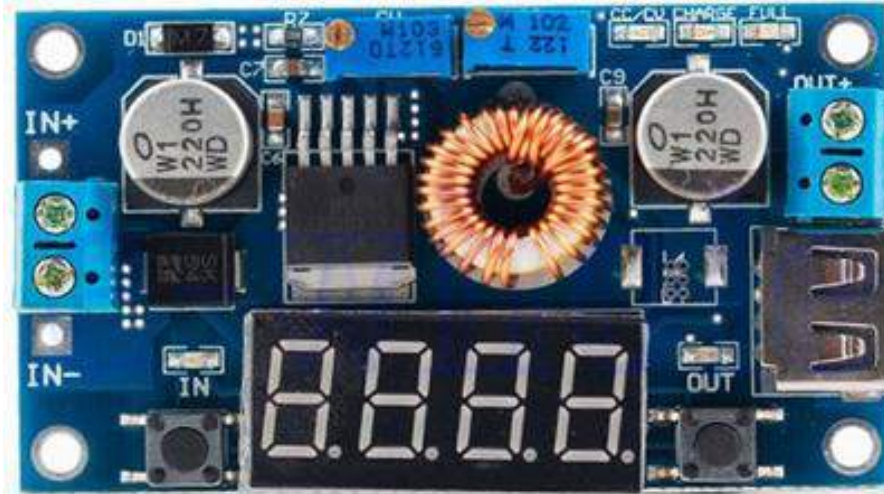


Figure 1. Stall protection board.

Stall Protection:

Stall protection is a new feature, starting with v1.6. This limits available torque from the motor, in order to prevent damage from overload. The Stall Protection Board can control both current and voltage, through PWM. Limiting current limits motor torque, while limiting voltage limits motor speed. If you have **any** trouble or questions with this, please don't hesitate to get in touch at filastruder@gmail.com.

On the board pictured above, there are two adjustments – labeled CV (left) and CC (right). Since the labels are at the very top of the board, it is difficult to see in the photo – but they're there. The adjustment knob on the left (CV) controls output voltage, while the adjustment knob on the right (CC) controls output current.

Note: you need to mind the polarity when connecting power to the board on the input terminals. Use a multimeter if in doubt.

To begin, rotate both adjustments counter-clockwise until you hear a soft click. This can be a few dozen rotations. The soft click is the minimum, or 0-turn setting. All numbers of turns are referenced from this.

CV (left) should be set to 15 or so turns clockwise. This should put it way up to the area that it is not limiting voltage at all, resulting in full speed extrusion. Check this by providing power to the board with nothing connected to the output terminals, and verifying the board reads roughly 12v.

CC (left) should be set to ~7 turns clockwise to start, which results in a current limit of 1.4-1.6 amps. Generally this is all the torque you need to extrude (roughly 12 N-m).

LED color codes:

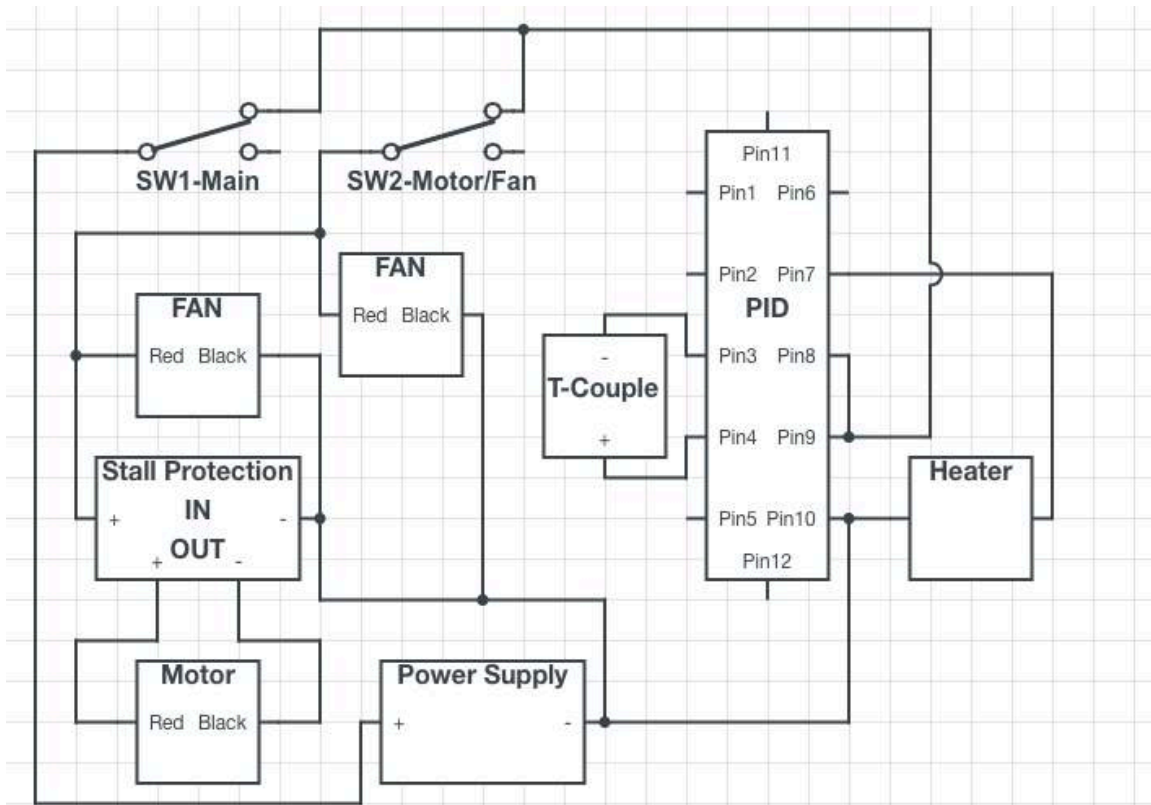
Red: Indicates the motor is being current limited.

Blue: Indicates motor is drawing between 10% and 99% of the current limit. This is normal.

Green: Indicates motor is drawing less than 10% of the current limit. This is possible if the motor is not driving a load.

Tapping the OUT button will cycle through the following measurements: Input voltage, output voltage, output current, output power, auto (cycles through all 4 every few seconds).

During normal operation, the motor should not be entering current limit mode. If it is, you can try an additional 2 turns clockwise (for a total of 9 turns from zero). If the motor is still entering current limit mode, something is probably wrong and you should contact support. (filastruder@gmail.com)



Notes:

This version is for the Sestos PID controllers.

SW2 is dependent on SW1. This prevents the motor from being switched on accidentally.

Schematic does not include autostart wiring, though the controller is capable.

Figure 2. Wiring Diagram – Sestos PID controllers

Step by step:

Positive of the power supply goes to the center pin of Switch-1 (SW1).

A wire goes from outer pin of SW1 to outer pin of the SW2, and to Pin 9 of the PID controller.

A jumper wire goes from Pin 8 to Pin 9 of the PID controller.

A wire goes from center pin of SW2 to the extruder fan red wire and to In(+) on the Stall Protection Board.

The motor fan red wire goes to In(+) on the Stall Protection Board.

The motor fan black wire goes to In(-) on the Stall Protection Board.

A wire goes from In(-) on the Stall Protection Board to Pin 10 of the PID.

The extruder fan black wire connects to Pin 10 on the PID.

One of the heater wires connects to Pin 10 of the PID.

The power supply's negative wire connects to Pin 10 on the PID.

The other heater wire connects to Pin 7 on the PID.

A wire goes from Out(+) to one motor terminal.

A wire goes from Out(-) to the other motor terminal.

Connect thermocouple, be mindful of the polarity, to Pins 3/4 of the PID.

Check that the motor rotates clockwise as viewed from the hotend. If not, reverse polarity to change direction.

Operation Instructions:

- 1.) Place assembly on a table, with barrel of the extruder hanging over the table.
- 2.) Set PID to 180 degC if using included ABS. Wait 10 minutes beyond the PID achieving 180C. During this time, please confirm the PID settings match the factory settings described in the included PID controller, also in the following PDF: <http://www.sestos-hk.com/english/download/d1s-en.pdf>
- 3.) Turn on motor. Frame should not flex significantly, and barrel should not turn. If it does, plastic is still solid inside the barrel. Wait longer for it to heat up before running motor.
- 4.) Using a tool so you don't burn yourself, guide filament over nozzle and to edge of table.
- 5.) Let Filastruder run for 6-8 hours producing filament to ensure contaminants are flushed out. These are the bits of metal from the cutting/grinding/filing that get stuck to the interior of the barrel. It is a good idea to autotune the PID during this time:
For the SESTOS PID, press and hold the SET key until the PV changes to HIAL, then press the SET key multiple times until you see CtrlL, then press the down arrow once to set it to 2 instead of 3. Then, hold the SET key until you return to the main temperature readout (Once you get to the EP's (EP1-8), you're close) and you will see that the SV will be blinking between a number and "At". This means that it is autotuning and you should now leave it alone until it stops blinking.
- 6.) After 8 hours, filament should be free of contaminants and can be used. Be sure to inspect a reasonable length of filament for contaminants before using in a printer. It may take more than 8 hours to flush out all the contaminants – using clear ABS can make it easier to be sure.
- 7.) Enjoy cheap filament!

Changing the Nozzle:

Simply heat up the Filastruder to operating temperatures, unplug it, remove the thermocouple, loosen the nozzle 1 turn each minute while the Filastruder cools, install the new nozzle, reinstall the thermocouple, and heat the Filastruder back up.

You may need to tighten the nozzle another half turn after heating. Be careful not to bend the barrel (metal pipe) - it may help to remove the 4 main bolts and slide the hotend out so that you cannot bend the pipe.

Of course, wear gloves and safety glasses during this!

Specifications:

- Extrusion Rate: 12-18 inches/minute with MG94 ABS (3-5 lbs/day)
- Extrusion Temperature: tested with 170-235C (email support for information on higher temps)
- Size: 21"x6"x6"
- Noise: 52dBA @ 3ft
- Power: 110-240VAC,50/60Hz, 75watts peak, 50 watts average

Helpful tips:

- Motor voltage changes pressure, and thus extrusion rate and diameter. Try to run at constant 12 volts, as that is what the motor is rated for. When the heater cycles on and off you may hear a slight shift in the sound emitted by the motor. The resulting changing in motor velocity is very small, it is just that the human ear can pick up on frequency shifts easily.
- Temperature changes viscosity, and thus extrusion rate and diameter. This is one way of dialing in filament diameter. 10degC is about 0.10mm, increasing temperature will decrease filament diameter. That also means that the tighter the PID holds temperature, the better. Autotuning the PID is a good idea.
- Another way of changing filament diameter moving the filament guide. Moving the guide further from nozzle increases the chances of the filament tangling/blobbing, be careful doing this.
- As you run out of pellets in the hopper, the extruded filament will exhibit a wave-like pattern. This means the extruder barrel is nearly empty.
- Keep the pellets and hopper clean, and covered when not in use. Garbage in, garbage out! If you let foreign material into the hopper, it may become part of your filament!
- Every 100 hours or so, inspect the thrust bearing and for signs of wear. Lubricate thrust bearing.
- Exercise caution. Though I've tried to cover all the bases in terms of material selection, etc., the truth is we're pressurizing hot, molten plastic. Eye protection is a good idea, and you should maintain safe distances when the motor is running. (don't put your eye up to the nozzle with it running!) It should still be plugged into a GFI outlet ideally, and never used near water or flammable products. Always use in a well-ventilated area, and use smoke detectors. **NEVER LEAVE UNATTENDED.**