SHERLINE PRODUCTS
INCORPORATED 1974

3D Printing System

P/N 8950

Contents (click on the subhead title to jump to that section)

I would like to first start by saying that Sherline Products is not in the business of manufacturing 3D printers. We manufacture tabletop milling machines and lathes. However, we believe that our mill is an excellent platform for a 3D printer.

When we first looked into offering a 3D print head, it was going to be another accessory that we made in house (in the U.S.A.) for our Sherline customers.

Shortly after we began making our prototype parts and doing R&D we found that you could buy an entire 3D print head from China for under $50.00. There was no way that we could compete in that market. Therefore, manufacturing the 3D head and other 3D components was not an option.

One of the unique abilities that our customers would have when creating 3D prints on our machine, is the ability to do finish machine work on their 3D parts after they were made. This is something that you can't do on a 3D printer.

Because we wanted to offer our customers the ability to use our Sherline mill as a 3D printer, we decided to move forward, but offer the 3D print head as a DIY (do it yourself) unit. We would sell the mounting brackets and alignment parts to mount the 3D head to our mill, and the customer could buy the rest of the parts online. However, because not everyone is a DIY type person and some just want a plug-n-play system, we also offer a complete system at a fair price.

Because our mills were designed to machine material, they will print 3D parts slower than a 3D printer. However, we have found the quality of the 3D prints on our mill are very good compared to most 3D printers of equivalent size.

You can use the 3D Printing Head on almost any of our Sherline mills. However, due to travel limitations on our smaller mills, and the versatility of our 2000 mill, we recommend that you use our 2000 mill. Any of the following mills would be a good choice too.

Preferred Mills in Order of Top Preference First

1. Any of the 2000 mills (http://sherline.com/product-category/mills/mills-8-direction-deluxe/)
2. Any of the NexGen 18" mills (http://sherline.com/product-category/mills/mills-nexgen/)
3. Our 12" mills (with (2) headstock riser blocks (P/N 1297) for deeper throat depth) (http://sherline.com/product-category/mills/mills-deluxe/).

You can mount the heat bed on our mill table, but we recommend that you use one of our tooling plates (P/N 3662 or P/N 3563). The tooling plate gives you a larger surface area to support the heat bed. It also elevates the heat bed so there is less interference with the Y-axis stepper motor.

NOTICE:

1. On the complete 3D Print-Head system, we warranty the parts that are made by Sherline Products ONLY.

   This would be the following parts:

   P/N 89505 3D Print-Head Bracket

P/N 89507 3D Print-Head Saddle Mounting Plate

P/N 89509 3D Print-Head Alignment Screw

P/N 89511 3D Print-Head Alignment Block

2. We do not warranty or offer replacement parts for any other parts in the 3D print head or heat bed.
3. You will have to contact the manufacturer for those parts, and for replacement parts.
4. There is a list of all of the components that we buy from outside manufacturers at the end of these instructions.

These instructions will cover both the complete plug-n-play system and the DIY system. We will start with the complete system.

Complete 3D Printer System: P/N 8950

1. Your 3D Print Head has already been aligned so the centerline of the print head nozzle is the same as the centerline of your Sherline Products headstock spindle.
   a. Included in your package is P/N 89511, 3D Print-Head Alignment Block. This is included so you can realign your print head in the event that you crash your head into the bed and knock it out of alignment. See section on "print-head alignment" later in these instructions.
2. First mount your heat bed to the mill table (or tooling plate). Center the heat bed on the table with the power cord facing the front.
   a. The heat bed comes from the manufacturer with a section of tubing that you are instructed to cut into (4) equal lengths to use as insulated spacer pieces under the bed. We don't use this method. There are (4) nylon washers included with your system. Place one of these under the bed directly beneath a hold down ((2) P/N 3012 Standard Hold-Down Set is recommended). (see Figure 1)

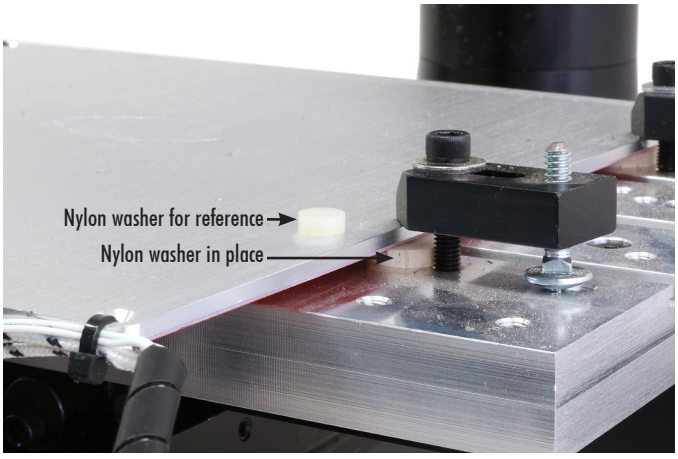


FIGURE 1

   b. Before you clamp the heat bed in place, move the table in the X and Y directions to see how much usable print area you will have. You may want to readjust the heat bed location or move the column (on 2000 mills) to gain more usable area.
   c. Since our mill table and our tooling plates are flat within .002 overall, the heat bed will also be flat. You should not have to do any leveling of the heat bed.
3. Mount your 3D printing head to the column saddle.
   a. The printing head will extend lower towards the table that the headstock. First, raise the Z-axis up for additional clearance above the heat bed.
   b. Remove the headstock and speed control from the column saddle.
   c. Mount the 3D print head onto the column saddle. Lock it in place with the set screw (make sure the head key is in place). (see Figure 2)

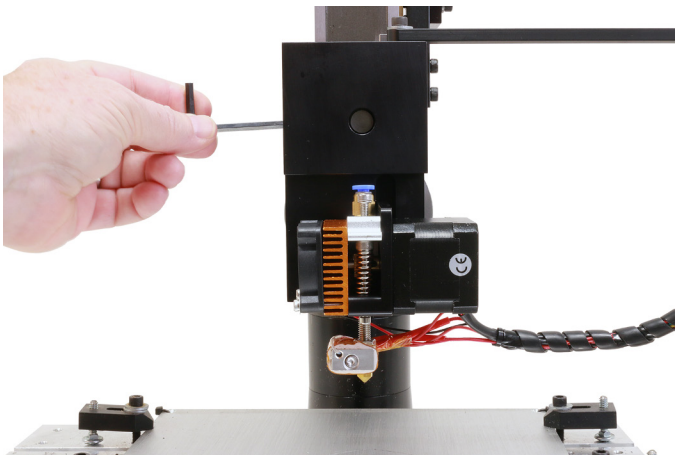


FIGURE 2

   d. Secure the wire cable into the hook bolt to hold them up and out of the way. Then zip tie them in place. If you don't have a zip tie a twisty tie from a bread wrapper will work just as well. (see Figure 3)

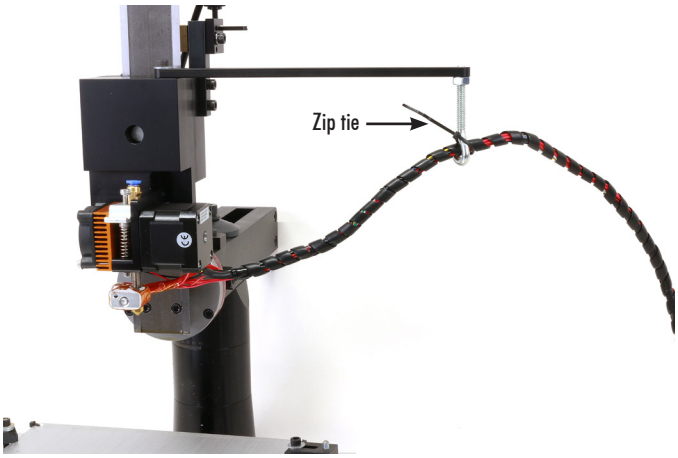


FIGURE 3

4. Control box and cable connections. (see Figure 4)

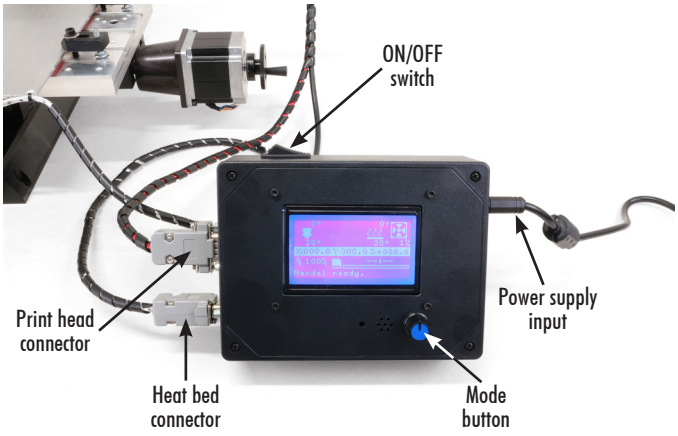


FIGURE 4

   a. Place your control box in an area at the front right side of your machine.
   b. Plug in the connectors for the print head and the heat bed on the left side of the box.
   c. Plug in the power supply cable on the right side of the box.
   d. Plug the 5 pin din cable that is on the print head into the "A" axis drive cable from your PC or our P/N 8760 CNC Driver Box. We use the A-axis cable to drive the print head stepper motor. (see Figure 5)

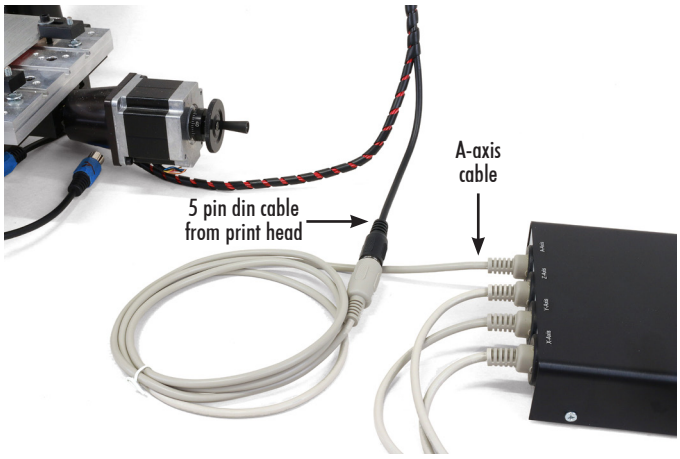


FIGURE 5

5. 3D printing instructions.

Notes:

1. The following instructions are for using the Sherline CNC system with Linux. If you are using a different system or software, you will need to play around with your feeds and speeds to get accurate 3D prints. The most important feed will be the "A" axis feed for the print-head stepper motor. If the feed rate is too high, the knurled drive wheel in the print head will just eat through the material instead of feeding the material through the nozzle.
2. When using our CNC and Linux, the printing process runs very smooth without any noticeable hesitation. However, when you use Mach3 or some of the other software there may be noticeable hesitation between moves or blocks of moves. This is not a sign of a problem with the print head, it is a software issue.
3. 3D print head and bed control.

These are general instructions to get you going.

For more Specific Instructions Go to the Websites Listed below

Here is a list of websites for support for the LCD controller, Marlin firmware, and the Arduino 2560 with RAMPS 1.4 boards.

1. Firmware - LCD Controller Menu.
   http://wiki.germanreprap.com/en/software/lcd_controller_menus
2. Information for the RepRap Full Graphic Smart Controller.
   http://reprap.org/wiki/RepRapDiscount_Full_Graphic_Smart_Controller
3. Marlin firmware user guide for beginners.
   http://solidutopia.com/marlin-firmware-user-guide-basic/
4. Description for Arduino 2560 with RAMPS 1.4.
   http://www.my-home-fab.de/Documentations/Technical-descriptions/Description-for-Arduino-2560-with-RAMPS-14/en

How to Install and Set up Arduino on Windows 7

https://www.youtube.com/watch?v=ylPpO-NG2pA

Here Are Some Reference YouTube Videos

1. Setting up an LCD and SD card controller panel.
   https://www.youtube.com/watch?v=H3wj9l1hvVw
2. Reprap - Dangers with ramps 1.4 wiring for beginners.
   https://www.youtube.com/watch?v=d-U_FwDP0kw

Let's Print a Part

1. Turn power switch on.
2. Now set your head and bed temperatures. For PLA the head temp should be between 180 – 190 degrees. The bed temp should be between 65 – 70 degrees.

Note: More information regarding temperature settings for different materials can be found here: https://devel.lulzbot.com/filament/Archive/LulzBot_3D_Printing_Filament_Guide.pdf

   a. Mode button works by either pushing it down to activate the screen and choose options, or turning it to select options.
   b. Press the mode button to get to the "control" screen.
   c. Turn the button CCW to select "control." Then press down on the button.
   d. Now turn the button CCW to select "temperature,"

press down to select.

e. Now turn the button to select Nozzle, turn CCW until you get to desired temperature (ex 187), then press down to set that temperature.

f. Go through the same steps as above but choose "bed," and set the bed temperature.

3. Now turn the head and bed temperatures on.

a. Press mode switch to get to "Prepare" screen.

b. Turn switch CCW to select "Prepare."

c. Press switch on "Prepare" to go to "Preheat PLA" page.

d. Turn switch to "Preheat PLA 1." Then press switch to activate nozzle heat.

e. Follow steps 3 – 5. Then turn switch to "Preheat PLA Bed." Then press switch to activate bed heat.

f. Your INFO Screen will show you the actual head and bed temperatures along with their programmed temperature settings. It will also show the fan logo in the top right corner. If this logo is changing, your fan is on, if not changing, it's off.

g. Once the head and bed temperatures are at the programmed level, you are ready to start printing.

3D Printing with Linux CNC

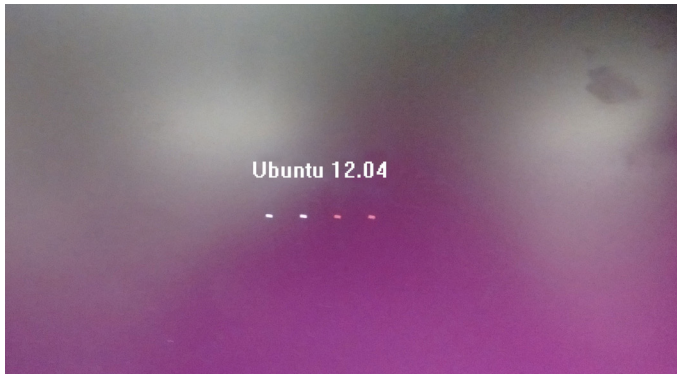
1. First you must reload Linux onto your computer in order to get the upgraded Sherline 3D inch and Sherline 3D metric Icons.

a. Very Important that you save all of your programs first. They will be lost when you reload Linux CNC.

b. Insert the new disk and reinstall Linux CNC.

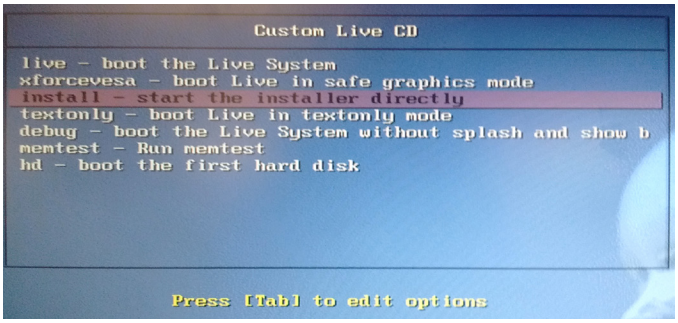
How to Install Ubuntu 12.04 LTS/Linuxcnc 2.6.11

1. Insert disk into CD/DVD drive and allow to boot.



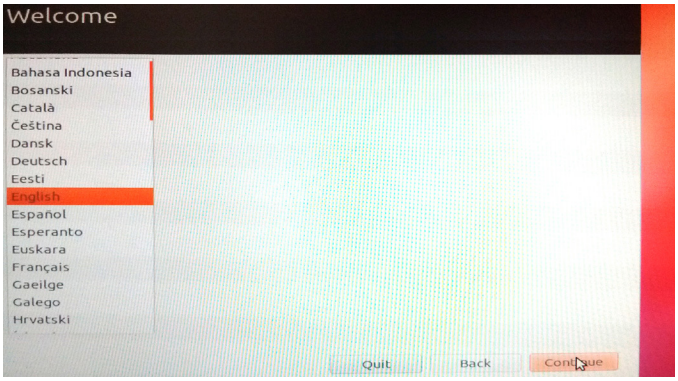
UBUNTU FIGURE 1

2. At "Custom Live CD" screen select "install-start the installer directly" and press Enter.



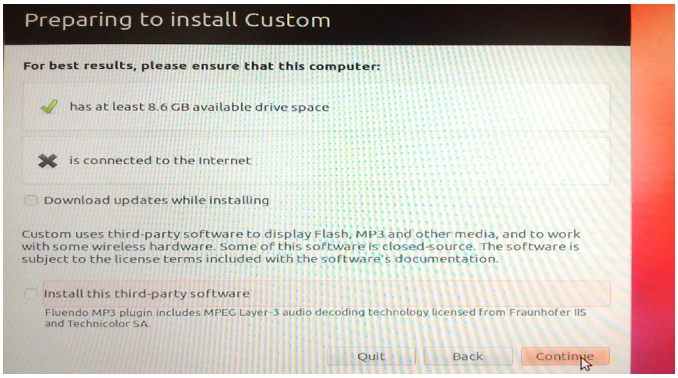
UBUNTU FIGURE 2

3. Select language and click Continue.



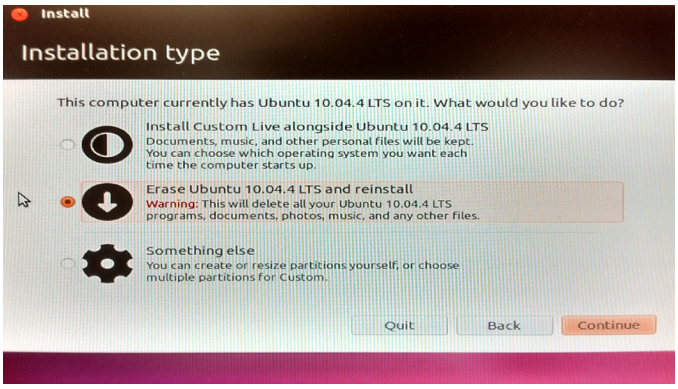
UBUNTU FIGURE 3

4. At "Preparing to install Custom" screen leave as is and click Continue.



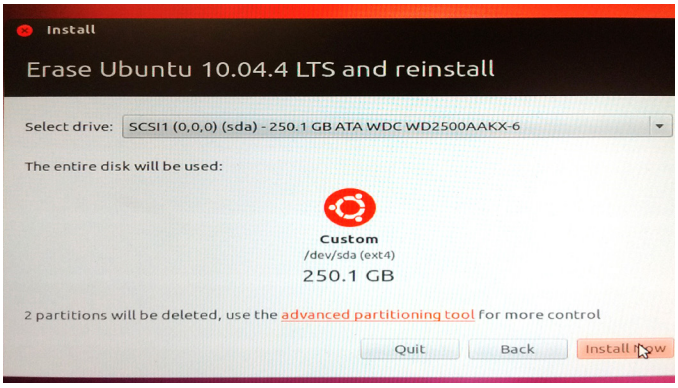
UBUNTU FIGURE 4

5. At "Installation type" screen select "Erase Ubuntu 10.04.4 LTS and reinstall" and click Continue.



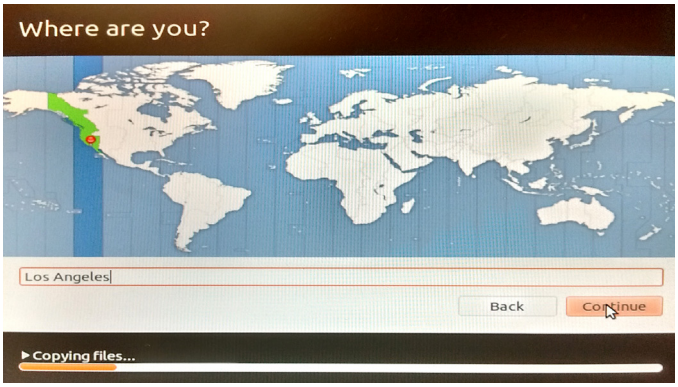
UBUNTU FIGURE 5

6. At “Erase Ubuntu 10.04.4 LTS and reinstall” click Install Now.



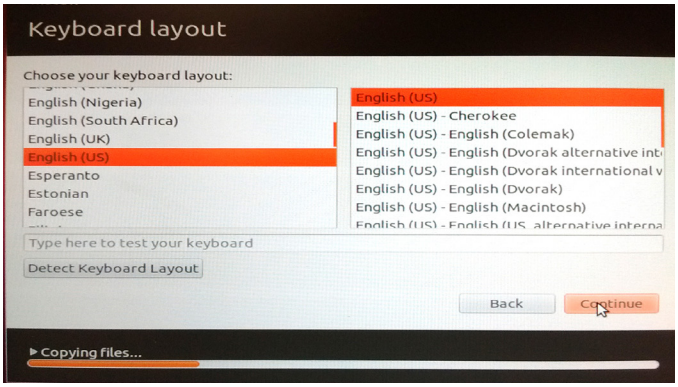
UBUNTU FIGURE 6

7. At “Where are you” screen select your time zone (Los Angeles shown for reference only) and click Continue.



UBUNTU FIGURE 7

8. At “Keyboard layout” screen select “English” and click Continue.



UBUNTU FIGURE 8

9. Allow to complete the Install process.

UBUNTU FIGURE 9

10. When Installation is complete the system will tell you to remove the disk and press enter. Then the computer will reboot.

Instructions for Set up of Repetier-Host Program (slicer program)

These instructions will cover the complete set-up of slicer program. Below are links for placing 3D model (STL file) and manual control.

Repetier host manual and the thingiverse site for 3D printable models.

https://www.repetier.com/documentation/repetier

https://www.repetier.com/documentation/repetier-host/rhmanual-control/

https://www-cdn.bq.com/file/Witbox/Manual_Repetier_EN.pdf

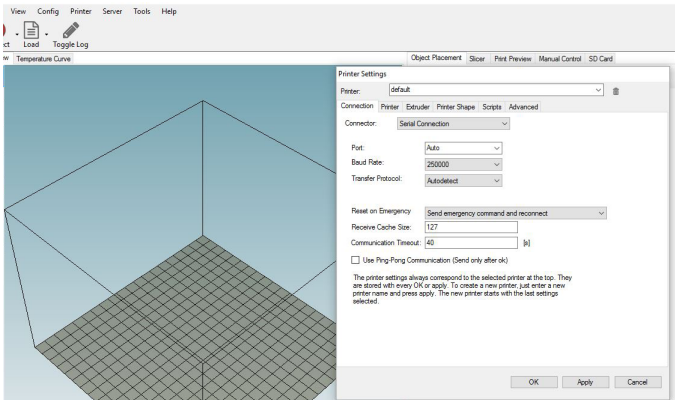
https://www.thingiverse.com/

Please download Repetier-Host and follow on-screen instructions:

https://www.repetier.com/download-software/

After installing Repetier-host please configure the software as follows:

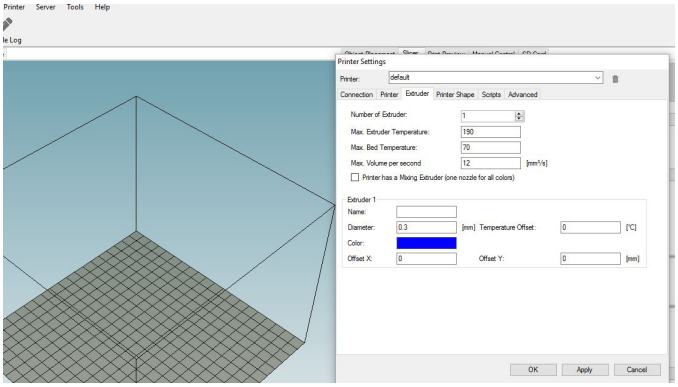
1. Click on the Config menu then go to Pinter Settings. On the connection page go to Port and set it to Auto by clicking on arrow and highlight Auto and click Apply.



REPETIER FIGURE 1

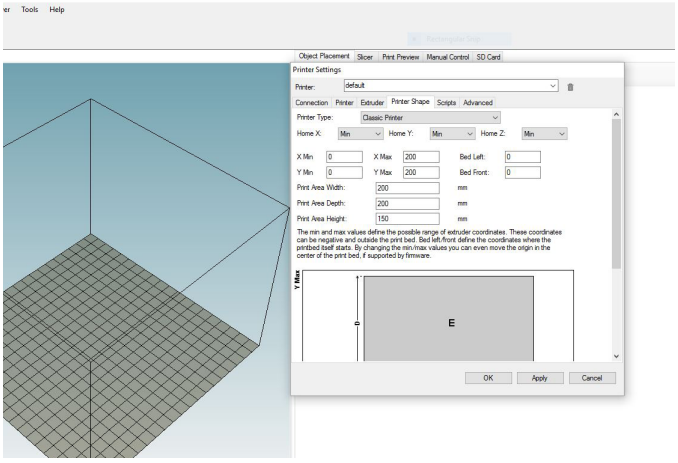
2. Next click on the Extruder tab, set Max. Extruder Temperature 190 for PLA or 230 for ABS. Next set

Max. Bed Temperature to 70 for PLA or 110 for ABS, then go down to Extruder 1 and set diameter to 0.3 (the default) and click Apply.



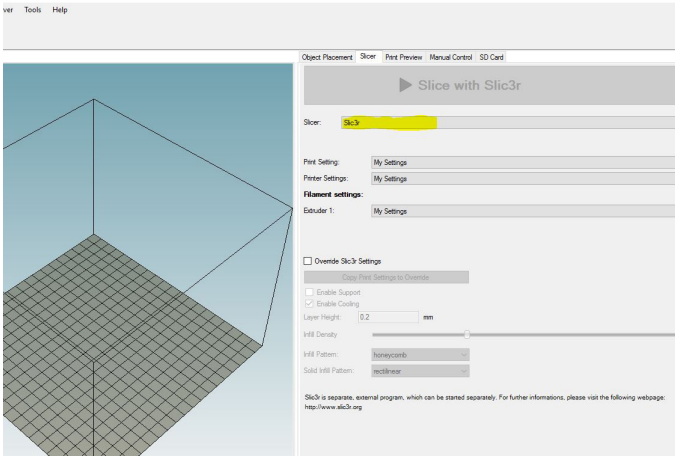
REPETIER FIGURE 2

3. Click on the Printer Shape tab and set to match example 3 below and click apply. Once settings are completed click OK.



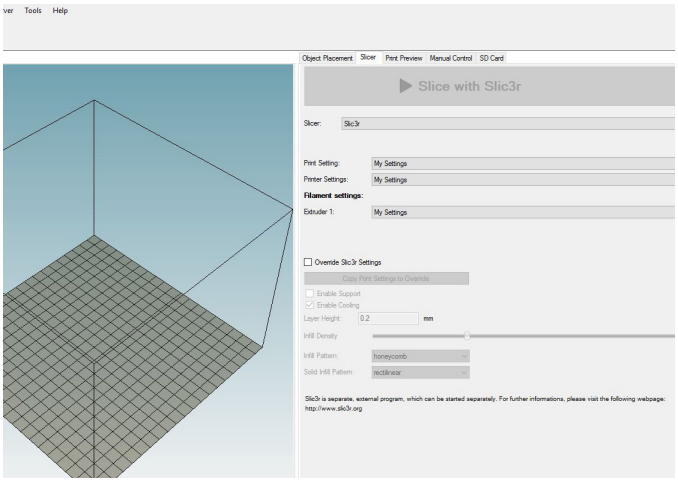
REPETIER FIGURE 3

4. In the box labeled Slicer (highlighted in yellow) select the Slic3r (if Slic3r is not in box then click on arrow to right and select Slic3r by clicking on it).



REPETIER FIGURE 4

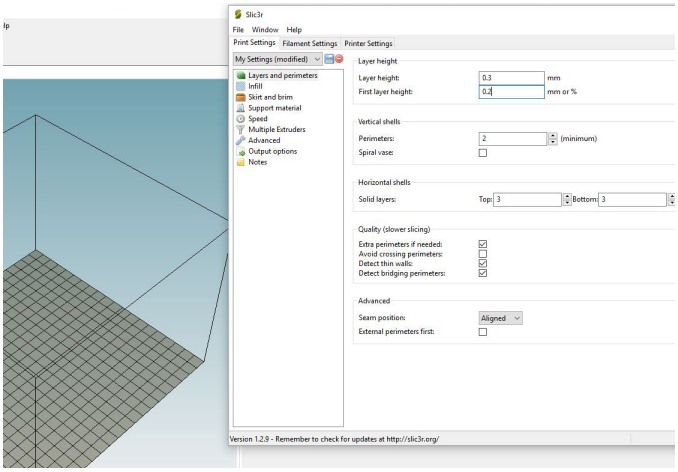
5. Next, go to the configuration box highlighted in yellow and click on it.



REPETIER FIGURE 5

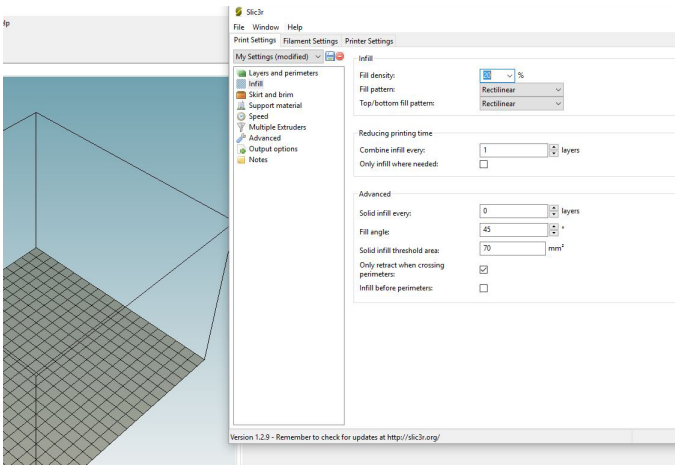
6. Under Printer Settings, settings are as seen in the following examples 6a and 6b.

6a. Layers and perimeters: match this setting, Layer height: 0.3mm and First layer height: 0.2 mm then click on the Save icon.



REPETIER FIGURE 6a

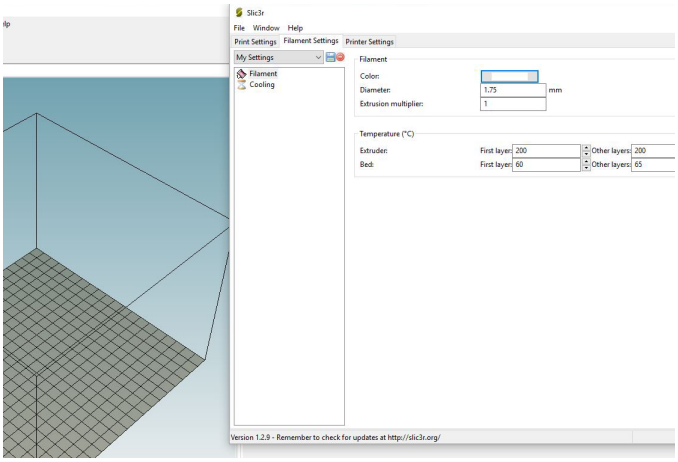
6b. Infill: set Fill density to 20% then click on the Save icon. Go to Filament Settings tab.



REPETIER FIGURE 6b

7. Filament Settings tab: change the number in the

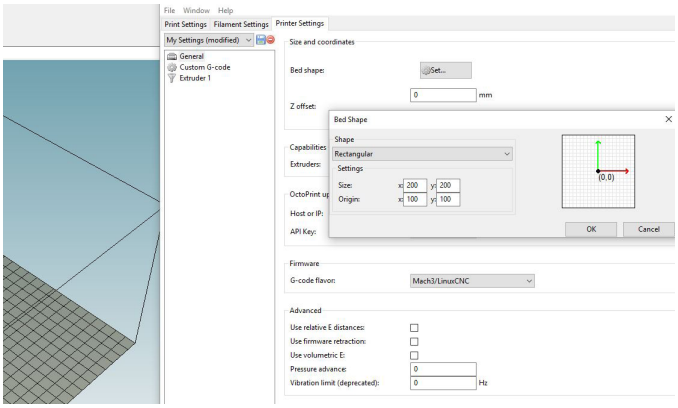
Diameter box to match the diameter of the filament you are using (default is 1.75 mm) and click on the Save icon.



REPETIER FIGURE 7

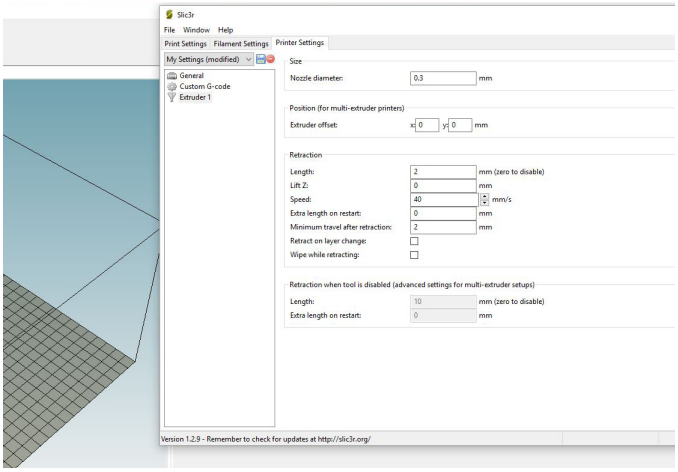
8. Printer Settings tab: set the Bed Shape by clicking on the Set box Set..., then under Shape select Rectangular and under settings set as noted below, then click OK.

Shape
Rectangular
Settings
Size x: 200 y: 200
Origin x: 100 y: 100



REPETIER FIGURE 8

9. Extruder 1: here you set the extruder settings. First one is Size-Nozzle diameter: 0.3 mm. Leave all other setting as they are and click the Save icon.



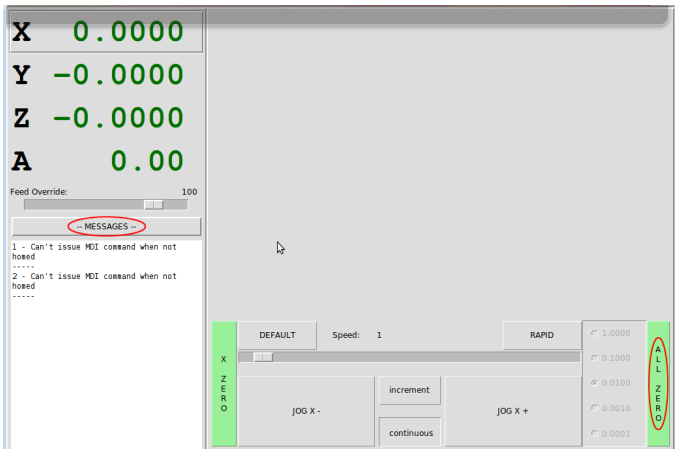
REPETIER FIGURE 9

Set-up is now complete and ready for use.

Before we start printing, there is a key difference between the 3D printers and our machines. Our machines don't have limit switches. The slicer software was made for all of the small 3D printers that are on the market that have limit switches. These machines also have more travel. This is why the first block in the slicer program makes it move 4" to 6" in the X+, Y+ direction before it starts to print your part. This is how we work around the long first move in the slicer program so it will work on our machine.

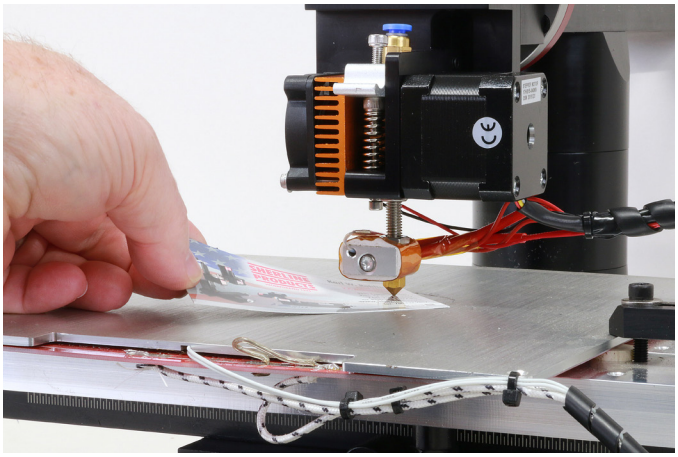
Note: There are several different options for a cover material for your heat bed. The most common are "blue painters tape" or "hair spray." We use the blue painter tape on our heat bed.

1. After applying the blue painters tape to the heat bed, put the machine in the manual mode. Now you can Jog the X-,Y-, and Z-axes. Use "continuous" for longer distance moves and "increment" for smaller moves.
2. Move your table so the print head is located roughly at the top right corner of the part that you are going to print. Then hit the "All Zero" button to zero out the machine. Then click on the "Messages" button to clear out the error messages.



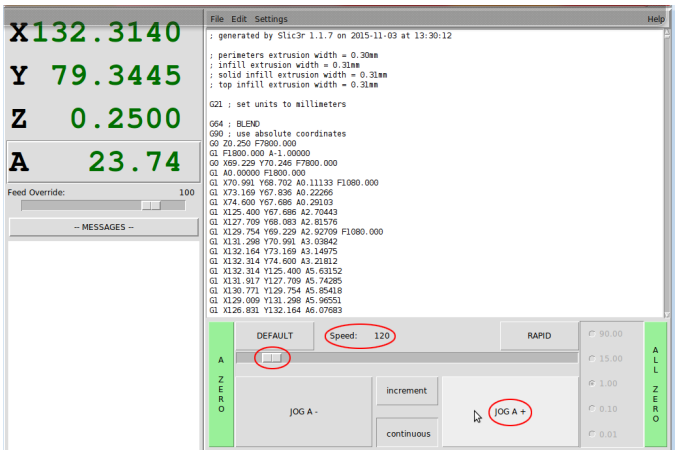
3. Now lower the Z-axis until it almost touches the top of the heat bed.

4. To get the proper distance from the heat bed to the tip of the nozzle, we use a business card (approx. .010-.012", .25mm).
5. Now switch to “Increment” and lower the head until the tip of the nozzle rubs on the business card. Start at an increment of .010" and the lower it to .001" when you get close. Move the business card back and forth under the nozzle while lowering the head. Stop lowering the head when you feel the nozzle start to pinch the business card to the heat bed. This is your Z (.25mm) position where the program will start printing.



6. Now push the “Z zero” button to zero out the Z-axis.
7. Using increment mode raise the head up Z+1.0".
8. Now we are going to load the material into the print head.
   a. Cut the lead end of the material at an angle so it will feed through easier.

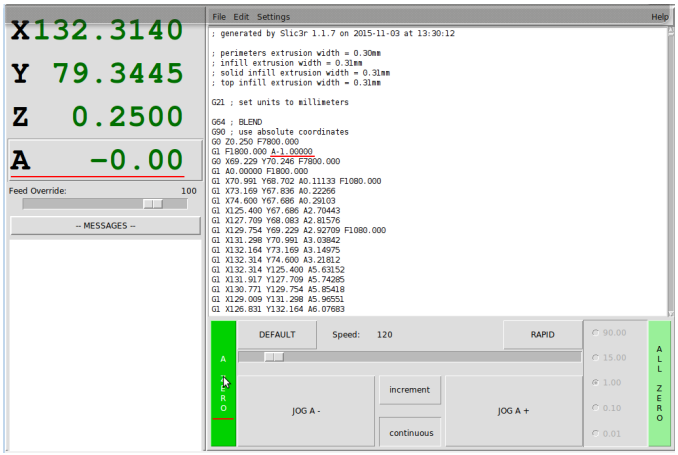
   b. Push the spring lever down and feed the material through the access hole and into the nozzle.
   c. Now switch to manual, “A” axis, and continuous. Move the feed rate bar to the left until it reads between 90 and 120.



   d. You will be jogging the A-axis in the + direction to feed the material through the nozzle.

   Note: If your feed rate is too fast, the knurled feed wheel will just cut through the material. If this happens, remove the material, cut off the bad section, feed it back into the head, lower the federate, and try again.

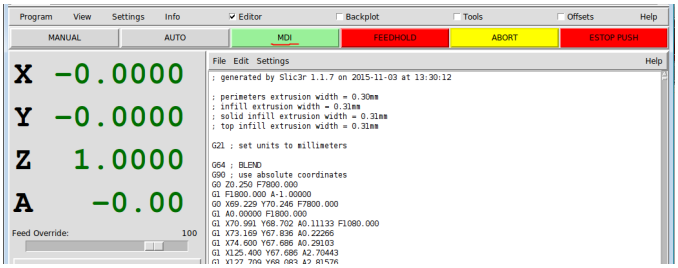
   e. Push the A+ jog button and hold it until melted material comes out of the nozzle.
   f. Wipe off the melted material on the nozzle so you will start clean. A pair of tweezers works best.
   g. **Most Important:** Zero out the A-axis now or the machine will rewind the drive wheel back to Zero when the machine reads the first line of code in the program which tells it to go to -1.000. Just click on the “A Zero” button as shown in the picture.



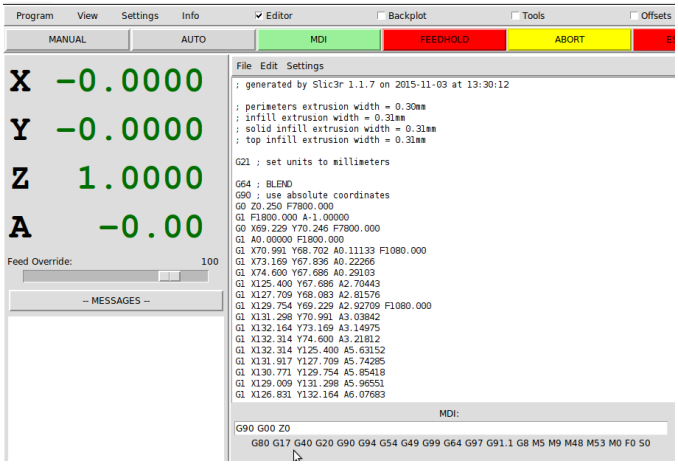
9. Now jog the Z-axis back down to Z Zero. You can either use the Jog, Increment mode, or the MDI Mode.

Let's use MDI (Manual Data Input) this time so you can learn something new.

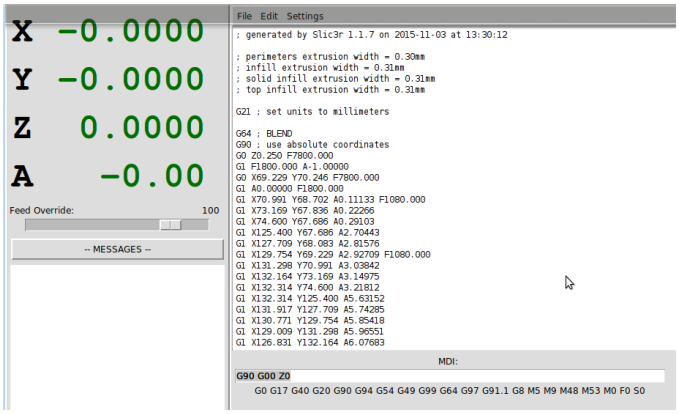
a. Click on MDI



b. In the Com Line at the bottom, type in G90 G00 Z0. G90 is for absolute positioning, G00 is for rapid move, and Z0 is telling the machine to go to Absolute Z Zero.



c. Now hit enter, and the Z-axis will move back down to Zero.

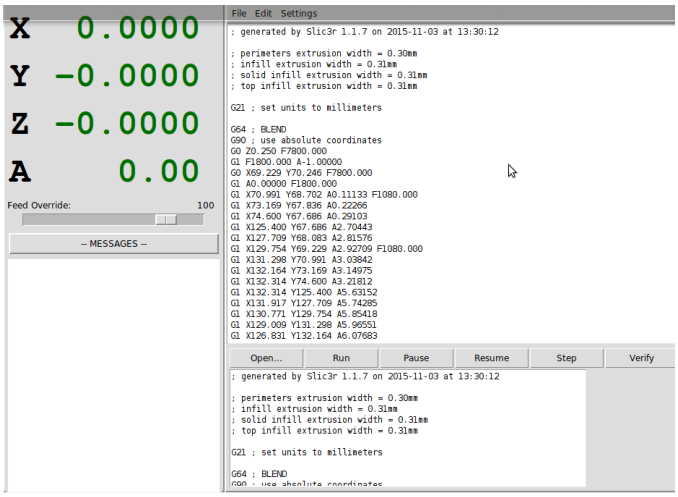


10. Now your print head is in the correct position to print your first part. Do the following steps:

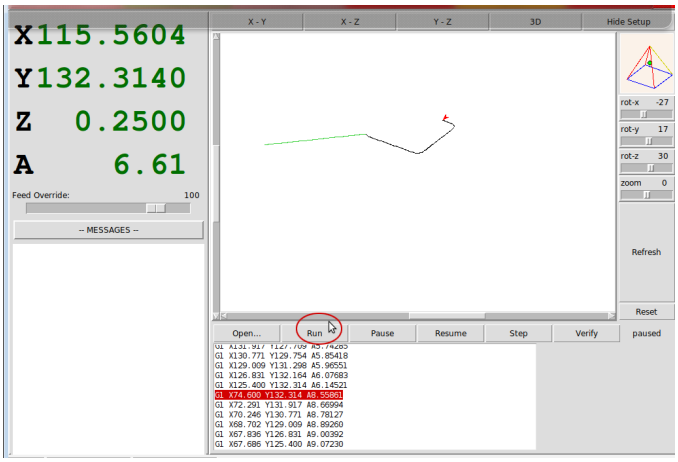
a. Turn the power switch for the stepper motors OFF.

b. Go to Auto Mode, File, Open. Choose the file that you want to run and hit enter.

c. Now choose File, and Save and Load. When you do this the program will show up in the bottom window, which means that it is ready to run.

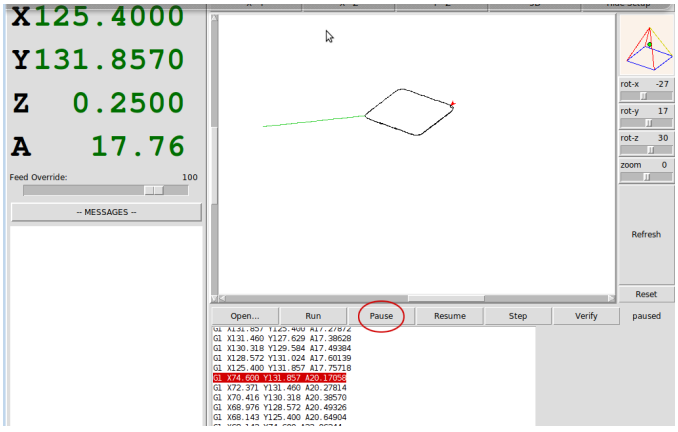


d. Now click on "Backplot," and then click on "Run."



e. Your program will start running. The green line is the rapid move from the home position to the bottom left corner of the "outline box" for your part.

f. When the backplot gets to the top right corner of the outline box, you are going to hit the "Pause Button."



g. Now you turn the power switch for the stepper motors back on. Then you click on "Resume." Now your parts will start to print and as far as your machine knows, your print head is at the absolute position that you paused at.

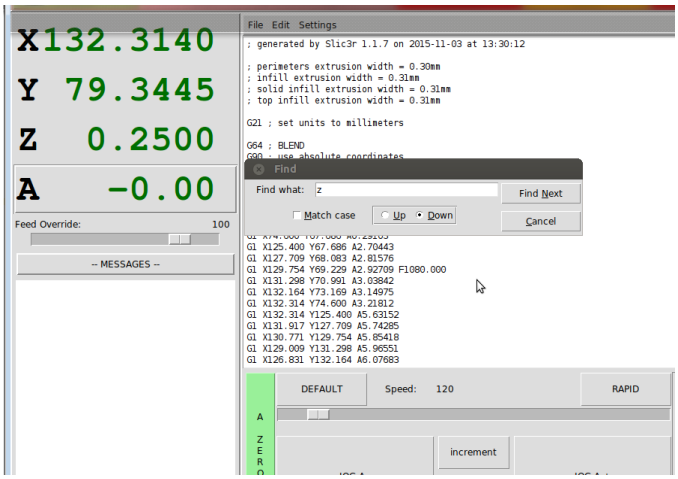
h. When your print is finished, turn off the head and bed temperature and allow your part to cool off. Once it is cool, you can pop the part off of the bed. Most of the time the part can be removed just by pushing on one side of it. However, if there is a large surface area in contact with the bed, this method will not work. For stubborn parts use a putty knife or similar tool to pry the part off.

11. A couple tips to help your printing process.

    a. For whatever reason, the slicer software leaves the Z-axis wherever it ends up at the end of the program. This means that the nozzle of your Hot print head will be on the top of your printed part, melting that area of your printed part until you come back and move it. If you are enjoying the freedom that your 3D printer gives you "to leave and design your next part while it is printing your last part" instead of watching it print all day. This means that the hot nozzle could be melting your part for some time.

To fix this possible dangerous situation, do the following:

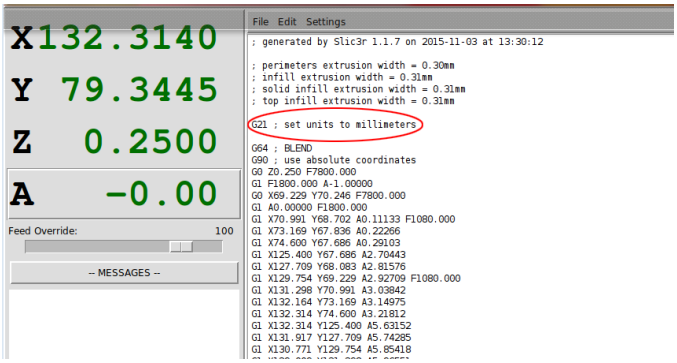
1. Click on "Edit" above the program window.
2. Then click on "Find."
3. In the "Find Box" enter "Z," then click on "down," and then start clicking on "Find Next."



4. Keep clicking until you get to the last Z-axis move in the program.
5. See what the last Z-axis position is (Example Z30.132).
6. What you want to do is insert a block at the end of the program, but before the "M02" and the "%" that tells it to move 50.0 higher than the last move. In this case a Z80.0 move would be fine. Insert "G90 G00 Z80.0."
7. Now when your program ends, the head will raise up 50mm above your part, and then stop.

    b. Your program must start with a "%" sign, or it will not run.

    c. All slicer programs generate G code programs in metric. Your program must have a G21 (Metric) at the beginning unless you are running your parts on a metric machine.



    d. The slicer software is set up for a 3D printer. Therefore, it puts in a lot of "M" codes in the G code program that the 3D printers use. Our mill with Linux CNC does not use any of them and it will alarm out whenever it reads one. Therefore, you must edit out All of the M codes that are in your program with the exception of M02 or M30 which go at the end of your program. Use the same method that we stated above for finding the Z-axis moves to find all of the "M" codes and delete them from your program.

    e. The fastest feed rate that our Sherline mill will go is 22 in/min. The slicer software programs will have much higher feed rates than that. It doesn't matter. Just leave them alone and know that you will be printing everything at 22 in/mi.

    f. We have edited the INI files for the 3D printer so the A-axis moves (which drive the print-head stepper motor) are scaled down so the material will come out at the proper rate for printing. If your print head is not feeding material fast enough, it is most likely a problem with the head. Either the spring tension of the knurled drive wheel is too loose, or the head is clogged and needs to be cleaned out.

List of parts to build the Sherline 3D printer

For the Heated Bed

FIGURE	DESCRIPTION
1a	Heat bed mk2b 12v-24v
2a	Anodized-Aluminum Heated build plate
3a	NTC 3950 Thermistor 100K with 1 Meter Cable Wire For 3D Printer

FIGURE 1a

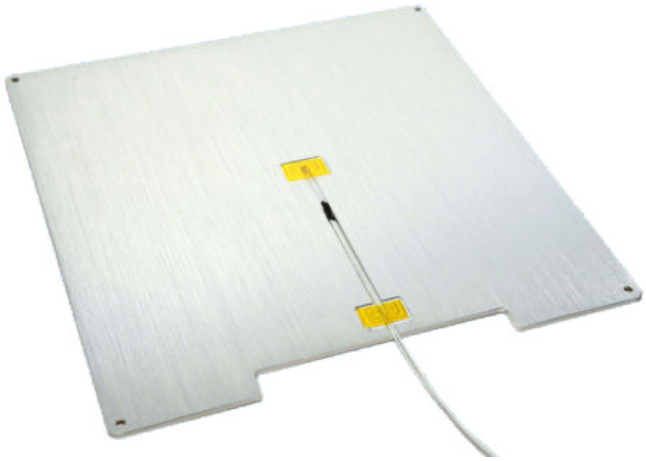


FIGURE 2a

FIGURE 3a

For the Print Head

FIGURE	DESCRIPTION
1b	GeeeTech MK8 extruder Print Head /W Nema 17 stepper motor
2b	Sherline 3D print-head adapter 2pc. Part numbers 89505 and 89507
3b	High Torque UNIPOLAR Nema 17 Stepper Motors (replacement motor due to compatible issues with Sherline 8760 controller)

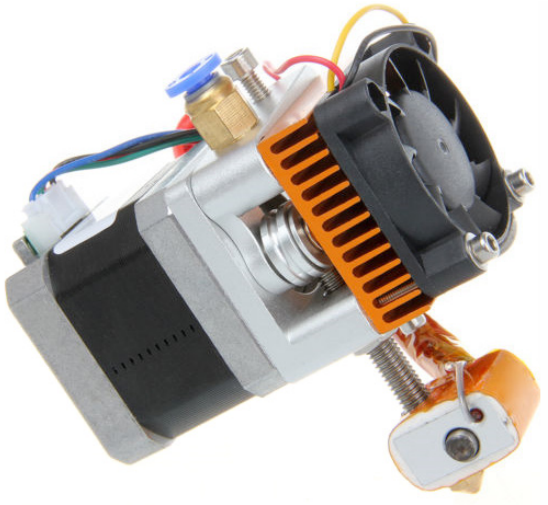


FIGURE 1b

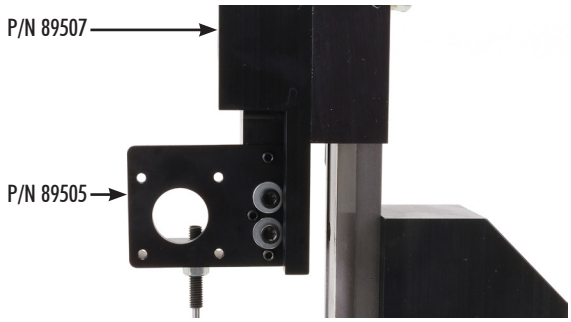


FIGURE 2b

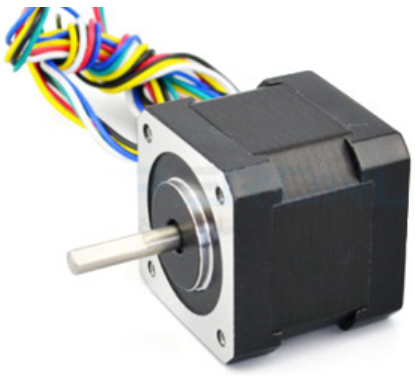


FIGURE 3b

For the Print Head/Heated Bed Controller

(This setup is used to control the print head's hot end, cooling fan, and heated print bed)

FIGURE	DESCRIPTION
1c	Arduino mega 2560 R3 microcontroller board
2c	Ramps 1.4 controller board
3c	Full Graphic LCD Display RAMPS 1.4 Controller for RepRap 3D Printer
4c	(Another option) AC Power Supply 85 – 245 VAC to 12VDC 10A

FIGURE 1c

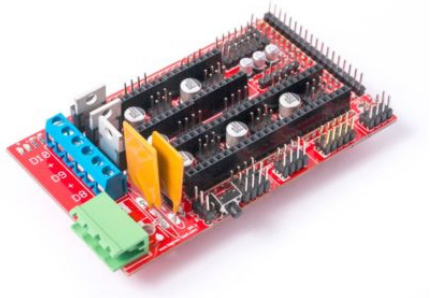


FIGURE 2c

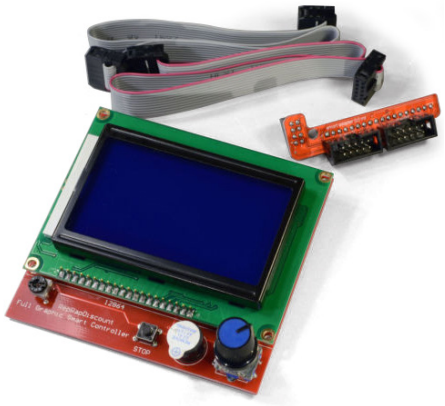


FIGURE3c

Wiring for the Project

FIGURE	DESCRIPTION
1d	4P-Dupont-Jumper-Wire-Housing-Female-Pin-Connector-2-54mm
2d	DuPont wire jumper cables 20cm 2.54MM male to female 1P-1P For Arduino

Note: cabling will have to be made to connect A-axis port on the 8760 controller to the wiring to the print-head motor. Cabling will also be needed to connect from hot end,temp sensor, and heated bed to mega 2560/ramps 1.4 controller connection.

FIGURE 1d

FIGURE 2d

Other Spare and Replacement Parts that may be Needed

FIGURE	DESCRIPTION
1e	Geeetech M6x38mm Nozzle Throat & Teflon PTFE for MK8 extruder Reprap 3D Printer
2e	Cartridge heater 6x20mm 12V 40W
3e	DRV8825 Stepper Motor Driver Module (only if you have larger stepper motors)

FIGURE 1e

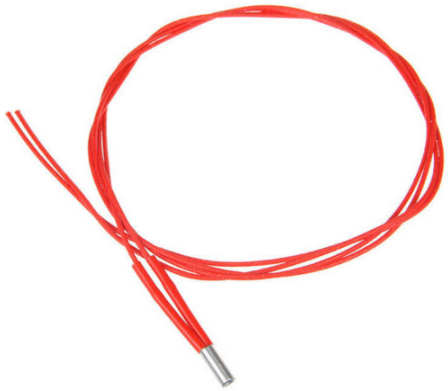


FIGURE 2e

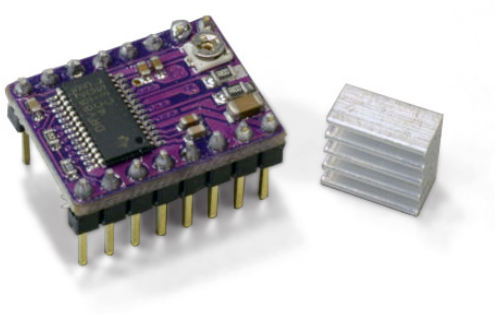


FIGURE3e

Software

	DESCRIPTION
1	3D modeling program (for make 3D model stl files)
2	Repetier host (slicing program to produce g-code for printer)
3	Marlin Firmware(used to control Mega 2560/ramps 1.4 controller for print head and hotbed)
4	Arduino software (IDE) software (to upload marlin firmware to Mega 2560/ramps 1.4 controller)
5	LinuxCNC (to run g-code for sherline mill with 8760 controller)
	or mach3 with CNC Driver dongle (to run g-code for sherline mill with 8760 controller)