

# Plans for manufacturing the Mini Metal Maker Pro

paste-extruding multimaterial 3D printer



Designed and manufactured by David Hartkop

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Plans for manufacturing the Mini Metal Maker Pro

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## 1. INTRODUCTION

### 1.1 About the Mini Metal Maker Pro

The *Mini Metal Maker Pro* is a commercial quality material extrusion 3D printer. It was initially designed to work with metal clay, but can just as easily work with ceramic clay or organic materials. It was manufactured by Mini Metal Maker LLC in Pueblo, Colorado from 2016 to 2018. The metal clay 3D printing technology for this printer was originally released as a DIY project, featured in the book, *Build Your Own Mini Metal Maker DIY*. The designs, however, were then improved and built into the solid all-metal commercial-quality machine presented in this book.

This compact high-precision printer extrudes material from an easily interchangeable syringe. The system garnered interest from both the metal clay and 3-D printing communities, and continues to be referenced by clay-extrusion 3D printer developers. While the machines were not a huge commercial success, they found a number of niche applications. Among them were metal clay jewelry, chocolate printing, and bio printing with stem cells.

It is the author's hope that publishing the plans will allow the project to live-on and find new uses in the exciting world of desktop manufacture.

### 1.2 Reader's right to produce the machine

The purchase of this book constitutes an agreement between designer David Hartkop at Idea Propulsion Systems LLC, (hereafter referred to as the author) and the purchasing party (here after referred to as the reader) such that the reader is permitted to build one (singular) *Mini Metal Maker Pro* metal clay 3D printer for personal use or design-verification purposes. The rights to manufacture a machine are not renewed by reselling the book; one machine may be built for one book purchased from the author.



*Author with a manufactured round of Mini Metal Maker Pro 3D printers being prepared for shipment, Pueblo Colorado 2016.*

If the reader wishes to manufacture additional units for a business, the reader may do so only after first contacting the author and obtaining a manufacturing license for producing the *Mini Metal Maker Pro*. Please contact the author at the following:

<https://www.ideapropulsionsystems.com/contact-us>

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## INTRODUCTION

### 1.3 Required tools and skills

This book contains all of the specifications for manufacturing the *Mini Metal Maker Pro*. This project requires a higher level of technical skill and a wider array of fabrication tools than did the *Mini Metal Maker DIY* printer.

The *Mini Metal Maker Pro* metal clay 3D printer is built from a number of commercially available components that are combined with custom fabricated parts. There are additional 3D printed parts intended to be produced in ABS plastic. While the overall design is simple, complete fabrication of the machine may require tools and expertise that are outside the capability of the home shop. This project involves use of tools such as the following:

1. **CNC plasma or laser metal cutter**
2. **Precision forming with press break**
3. **Bandsaw angle cutting**
4. **MIG or TIG welder**
5. **Spot welder**
6. **Drill press or punch**
7. **FDM 3-D printer for ABS plastic**
8. **CNC Mill**
9. **Thread taps (metric and US)**
10. **Soldering iron**

The required components and previously used suppliers are listed, along with part numbers where available. In terms of dimensioned drawings, all figures are given for the developed part, but do not account for the cut methods used. If, for instance, a plasma cutter is used to cut out the box pattern, it will fall to you or your machine shop to determine the proper cut settings and bend allowances for the material that you use.

Directions for assembly are given in a simplified order-of-operations form where it matters. This book is intended to be used by a fabrication professional, and so are not very detailed. Most drawings show

how the parts fit together, and not necessarily the step-by-step instructions for assembly.

The 3D models that are to be printed for this book are available for download from several online locations. Dimensioned drawings of the 3D printed parts are also provided, should you or your machine shop wish to generate your own models with your choice of software.

The Arduino firmware and software originally prescribed for the *Mini Metal Maker Pro* are all available as a free download online from several locations as well. A set of electronic schematics and robotic drive parameters are also given, should you or your company wish to develop your own software.

### 1.4 Note about extrudable metal clay material

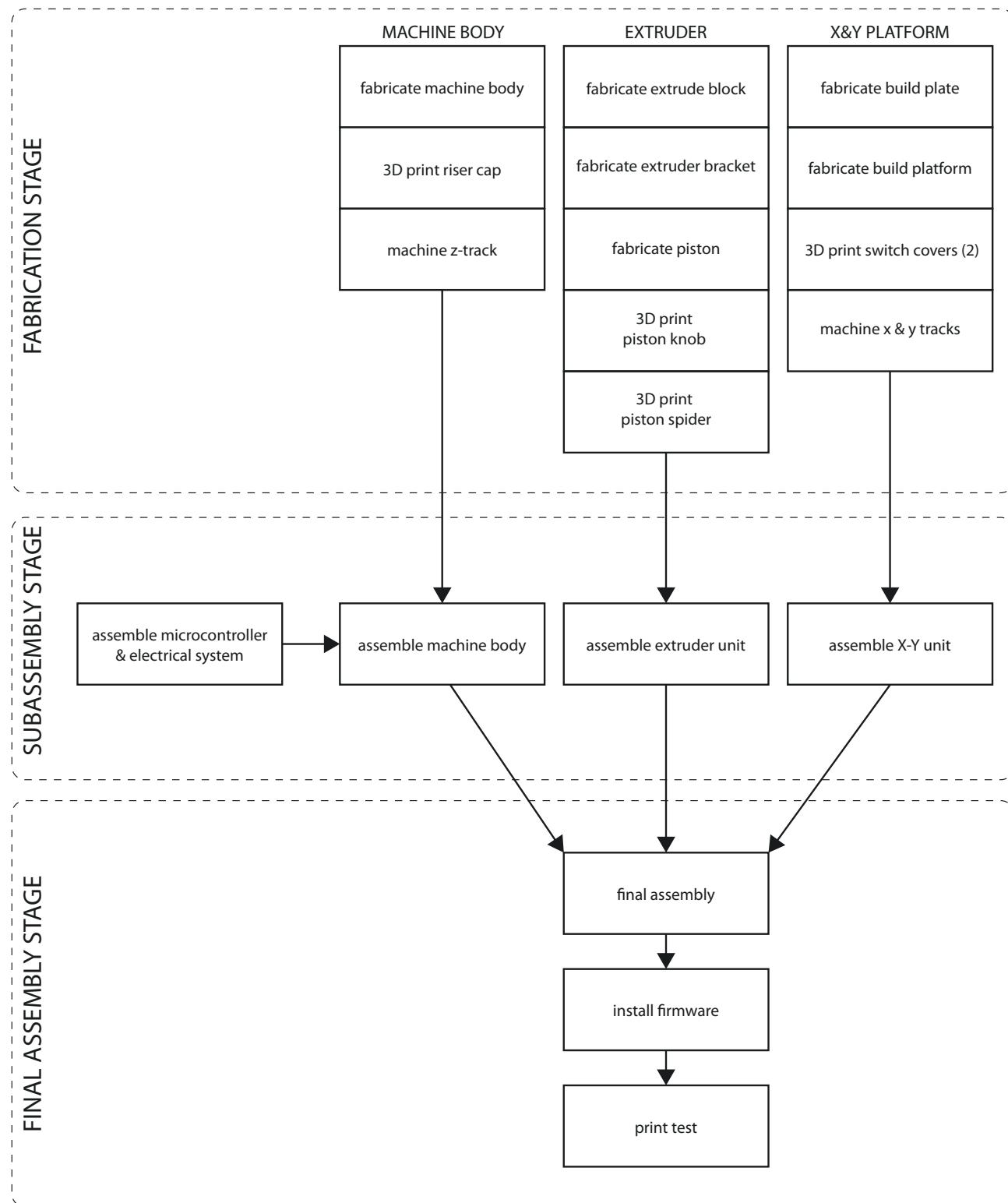
The viscous metal clay material that was originally sold along with the *Mini Metal Maker* is no longer available from its original manufacturer. It was found that production and sale of pre-wetted metal clay was troublesome because of shelf-life issues. The author recommends reconstituting metal clay from a powder form and then loading it into a syringe near the time of use.

### 1.5 Overview of MMM manufacture process

The *Mini Metal Maker Pro* was commercially manufactured for a time, and the process of doing so was broken into three major stages. (See Figure 1.5a) The Fabrication Stage includes all machine shop work and 3D printing required to create the base components. These fabricated parts will be combined with other commercially available supplies in the Subassembly Stage. Finally, all the subassemblies are combined into the finished machine in the Final Assembly Stage.

## INTRODUCTION

Figure 1.5a - Manufacturing process overview for the Mini Metal Maker Pro



## 2.1 List of materials to order (1 of 4)

Category	Item Description	Specs or Part#	Supplier	# Per MMM
Electronics	Adhesive zip tie anchors	3/4" self-adhesive zip tie anchors, black	misc. hardware supplier	5
Electronics	Adjustment Knob	6mm adjustment knob with number scale 1-10	misc. hardware supplier	1
Electronics	Arduino/Ramps w. Stepper Drivers 3D Printer Kit	Arduino Mega 2650 and Pololu RAMPS V1.4 with 4 x A4988 stepper drivers	SainSmart.com or similar	1
Electronics	Endstop Switches	AC 125V 1A Momentary Long Hinge Switch	misc. electronics supplier	2
Electronics	Extruder Motor	Gear Ratio 27:1 Planetary Motor Nema 17 part #17HS19-1684SPG27	STEPPERONLINE	1
Electronics	Fan	12v 40mm 2 pin	misc. electronics supplier	1
Electronics	Fuse Holder	1/4" tubular fuse holder, f1468-nd	digkey	1
Electronics	Fuses	5 amp 5 x 20mm	digkey	1
Electronics	Gorilla Tape	2 in heavy fabric adhesive tape, permanent bonding, black	misc. hardware supplier	1
Electronics	header sockets (2 pin)	Dupont Jumper Pin Header Connector housing Male/Female 1x2 0.1in spacing	misc. electronics supplier	3
Electronics	header sockets (4 pin)	Dupont Jumper Pin Header 1x4 Male/female 0.1in spacing	misc. electronics supplier	5
Electronics	Heat sink	10mm square heat sink for A4988 pololu stepstick stepper driver board	SainSmart	1
Electronics	Inductor - torroid	28B1225-000	digkey	1
Electronics	Inductor - USB cable clamp on	28A0593-0A2	digkey	1
Electronics	Inductor - vortex port torroid	28B0686-100	digkey	1
Electronics	Inductor - xy stage wires clamp on	28A2025-0A0	digkey	1
Electronics	nylon weave cable tube	100' of 3/8" Expandable Polyester Sleeving No.1030-1041-ND	digkey	40
Electronics	Potentiometer	potentiometer B10K 10K ohm, No X000M3YLPB	misc. electronics supplier	1
Electronics	Power cable	120VAC utility power cable for power supply, 839-1185-nd	digkey	1
Electronics	Power Jack	DC power, 2.1mm Center offset, panel mount 12.6 DIA x 18.0 LG	Jameco	1
Electronics	Power Supply	Model TE60A1203F01 12v 5A pwr supply	digkey	1

## 2.1 List of materials to order (2 of 4)

Electronics	Power Switch	ball toggle Switch 30-1720	misc. electronics supplier	1
Electronics	Tactile switch	Momentary tactile push button 4 pin, low profile all metal body	misc. electronics supplier	3
Electronics	USB Cable	6' black USB printer cable No. Q364-ND	digitek	1
Electronics	Wire, Black	20 ga	misc. electronics supplier	34
Electronics	Wire, Black	26 ga hookup wire	misc. electronics supplier	70
Electronics	Wire, Blue	26 ga hookup wire	misc. electronics supplier	100
Electronics	Wire, Green	26 ga hookup wire	misc. electronics supplier	52
Electronics	Wire, Red	26 ga hookup wire	misc. electronics supplier	60
Electronics	Wire, Red	20 ga	misc. electronics supplier	34
Electronics	Wire, Yellow	26 ga hookup wire	any electronics supplier	170
Electronics	XY Motors	42mm frame size 12V Nema 17 Two Phase Stepper Motor, 42mm length	misc. stepper motor supplier	2
Electronics	Zip Ties	4 in	misc. hardware supplier	8
Electronics	Z Motor	Nema 16 Linear Stepper Motor 39BYGL215A	Wantai Motor	1
Custom Metal Fab.	Base Box Electronics Enclosure	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Body riser L	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Build Platform base	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Build Platform build plate	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Extrude stainless tube	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Extruder - Elevator Block	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	Extruder - Extruder Block	see included dimensioned drawings	commercial metal fabricator	1
Custom Metal Fab.	X-Rail made from iGUS part	see included dimensioned drawings	commercial metal fabricator	1

## 2.1 List of materials to order (3 of 4)

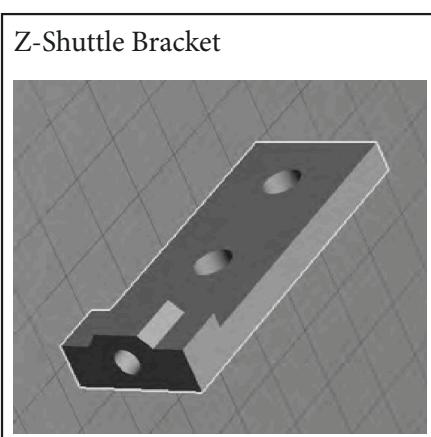
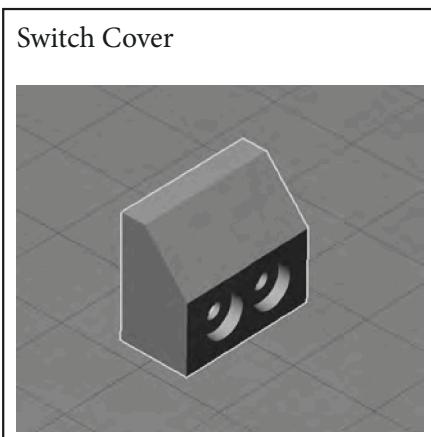
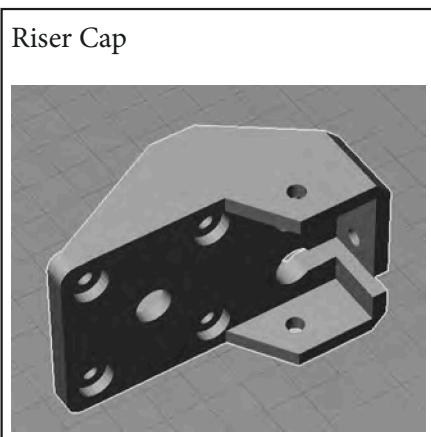
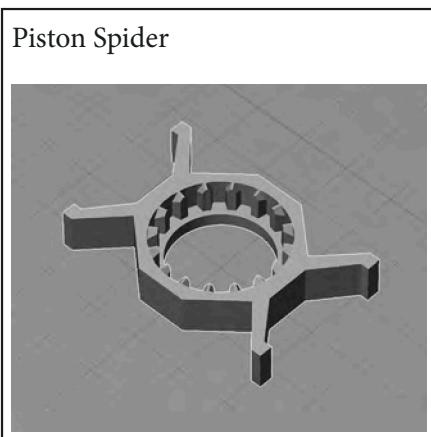
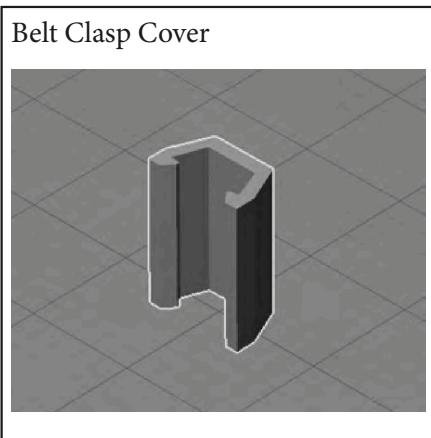
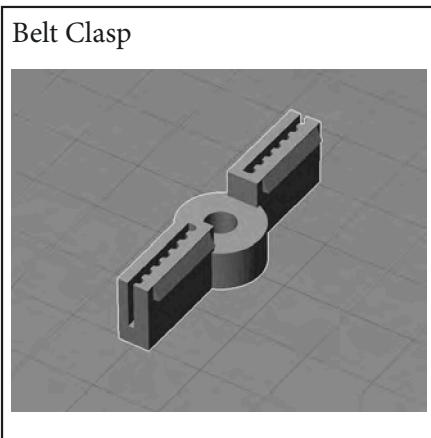
Custom Metal Fab.	Y-Rail made from Igus part	see included dimensioned drawings	commercial metal fabricator	1
Hardware	BELT CLAMPS	3D printed part	3D Print Shop	2
Hardware	BUSHING idler	GSI-Q2D3-06	Igus	4
Electronics	CRIMP CONNECTOR	Female crimp connector pin for 22 AWG wire # WM16732CT-ND	Digikey	25
Hardware	ENDSTOP COVER	3D printed part	3D Print Shop	2
Hardware	Extruder Knob Spider	3D printed part	3D Print Shop	1
Hardware	Switched auxiliary power port	3.5mm mono audio plug - open circuit No. SC1455-ND	digikey	1
Hardware	NUT- 1/4-20 Tee nut for extrude piston	1/4-20 tee nut, Stainless	misc. hardware supplier	1
Hardware	NUT- 6-32 for idler pulley	6-32 nut	Fastenal	2
Hardware	NUT- M3 for circuit board mount	M3 nut	Amazon.com	2
Hardware	PULLEY - idler & drive pulleys 16 teeth	T16. 5mmBore GT2	misc. hardware supplier	4
Hardware	RISER CAP	1.5 in square, black	misc. hardware supplier	1
Hardware	Square plastic tube plug		misc. hardware supplier	3
Hardware	RUBBER FEET	3M Bumper SJ5023 .81in wide x 0.3in high (36 per sheet)	misc. hardware supplier	
Hardware	SCREW - 6-32 x 1/4 BLK idler	6-32 x 1-1/4 black hardened steel (0148809)	Fastenal	2
Hardware	SCREW - m4 x 12mm taper, allen	m4 x 12mm taper, allen	Fastenal	3
Hardware	SCREW - Self drill 1/8"	Self drill 1/8" x 1/2 inch	Fastenal	2
Hardware	fan mount		McMaster	6
Hardware	SCREW- 1/4-20 x 4" E-drive screw	1/4-20 x 4"	Fastenal	1
Hardware	SCREW - M2 X 0.4 10MM Endstop switches + Tee Nut	M2 x 0.4 10mm machine screws	McMaster	
Hardware	SCREW - M3 .5 x 6		Fastenal	16
Hardware	stepper motors mounting		Fastenal	
Hardware	SCREW - m3 x 25mm circuit board mount	m3 x 25mm (Part 9193)	Fastenal	2
Hardware	Z-shuttle mount	M4 .5 x 12, button, allen	Fastenal	2
Hardware	SCREW - m4 x 8 SET SCREW	m4 x 8 set screw (40829)	Fastenal	6
Hardware	X & Y rail mounts			

## 2.1 List of materials to order (4 of 4)

Hardware	SCREW - M4x0.7 x 8mm, button, allen bolt X shuttle to Y rail, X-rail mount to box, Z-shaft coupling, Z M4x0.7 x 8mm, button, allen (MB2530008A20000)	Fastenal	15
Hardware	SHAFT COUPLER - 5mmx8mm spring cut extruder section	5mmx8mm spring cut	misc. hardware supplier
Hardware	SPACER - 1/4 x 5/8 x 3/8" nylon Z-shuttle spacer	1/4" ID x 5/8 OD x 3/8" long nylon spacer	misc. hardware supplier
Hardware	SPACER - .114x0.7x12 zinc X & Y shuttle risers & Z-shaft coupling	m4x0.7x12 zinc	misc. hardware supplier
Hardware	SPACER - nylon M3 X 6MM circuit board standoff	nylon M3 X 6MM	misc. hardware supplier
Hardware	SPRING - belt tension spring	tension spring for 6mm timing belt	misc. hardware supplier
Hardware	SPRING - Levelling springs	C10-035-012	Jones Spring Co / McMaster Carr
Hardware	STAINLESS CAP - 3/8" ID, 1/2" extuder piston	stainless cap insert 3/8" ID, 1/2"	misc. hardware supplier
Hardware	syringe clamp cable gland	3/4" thread nylon black .561-.709 / gland=CG375B, nut=LNP300B	Essentra Components
Hardware	Timing belt	1 meter 2mm pitch, 6mm wide belt	misc. hardware supplier
Hardware	WASHER - #10 Nylon idler pulley	#10 Nylon	Fastenal
Hardware	WASHER - #6 split ring idler pulley & circuit board	#6 split ring washer	Fastenal
Hardware	WASHER - M4 ZINC X&Y Shuttle risers	M4 ZINC (1140353)	Fastenal
Hardware	X-Y Rails	80mm Aluminum Rail, 220mm long - NS-01-80S, (no holes)	Igus
Hardware	X-Y Shuttle	NW-02-80, no floating	Igus
Hardware	Z Shuttle	NW-02-40, no floating	Igus
Hardware	Z-Rail	NS-01-40, standard holes 140mm	Igus
Misc	Build plate magnet square	4x4"	misc. graphics print shop
Misc	Copper tape for build plate sensors	1/8" wide copper foil tape	misc. hardware supplier
Misc	extrude nozzle	20ga Industrial Dispensing Tips	CML SUPPLY
Misc	Kapton tape for build plate sensors	3/8" wide kapton (polyimide) tape	misc. hardware supplier
Misc	Machine decal	1/2" Cut vinyl MMM logo Decal	misc. graphics print shop
Misc	Paint	Krylon	misc. graphics print shop
Misc	Extrusion syringe for print material	LOCTITE 0.719 in O.D. Syringe barrel #8900180	LOCTITE, ROCKY HILL CT.
			10

## 2.2 Parts to 3-D print and notes for printing

Item to 3D Print	Overall Dimensions (mm)	# required
Belt Clasp	12.4 x 41.2 x 10.3	2
Belt Clasp Cover	9.3 x 5.7 x 13.5	4
Piston Knob	27.3 x 27.3 x 20	1
Piston Spider	44 x 27 x 7.6	1
Riser Cap	76 x 38 x 47	1
Switch Cover	16.3 x 8.3 x 14.6	2
Z-Shuttle Bracket	9.8 x 53.8 x 22.8	1



### 3-D Printing Notes:

Material: ABS  
 Layer Height: 0.2 mm  
 Shells: 2  
 Infil: 50%  
 Infil Pattern: Hexagon  
 Supports: only needed for riser cap object.

## **2.2 Parts to 3-D print and notes for printing (continued)**

### **DOWNLOAD 3D OBJECTS:**

3D object files for printing the Mini Metal Maker Pro can be downloaded from any of the following locations:

Idea Propulsion Systems Website

<https://www.ideapropulsionsystems.com/minimetalmakerpro>

Github

<https://github.com/dhartkop/MiniMetalMakerPro>

Google Drive

<https://drive.google.com/open?id=1qV-3hYl3GlgRwa2RdNpjQ69LkKmCXT83>

(<https://tinyurl.com/ya7lxzjl>)

Drop Box

<https://www.dropbox.com/sh/klfxlgpdh6nvpl/AABd70FIQnrCqQLtLTAf8ZkPa?dl=0>

(<https://tinyurl.com/ybynyh38>)

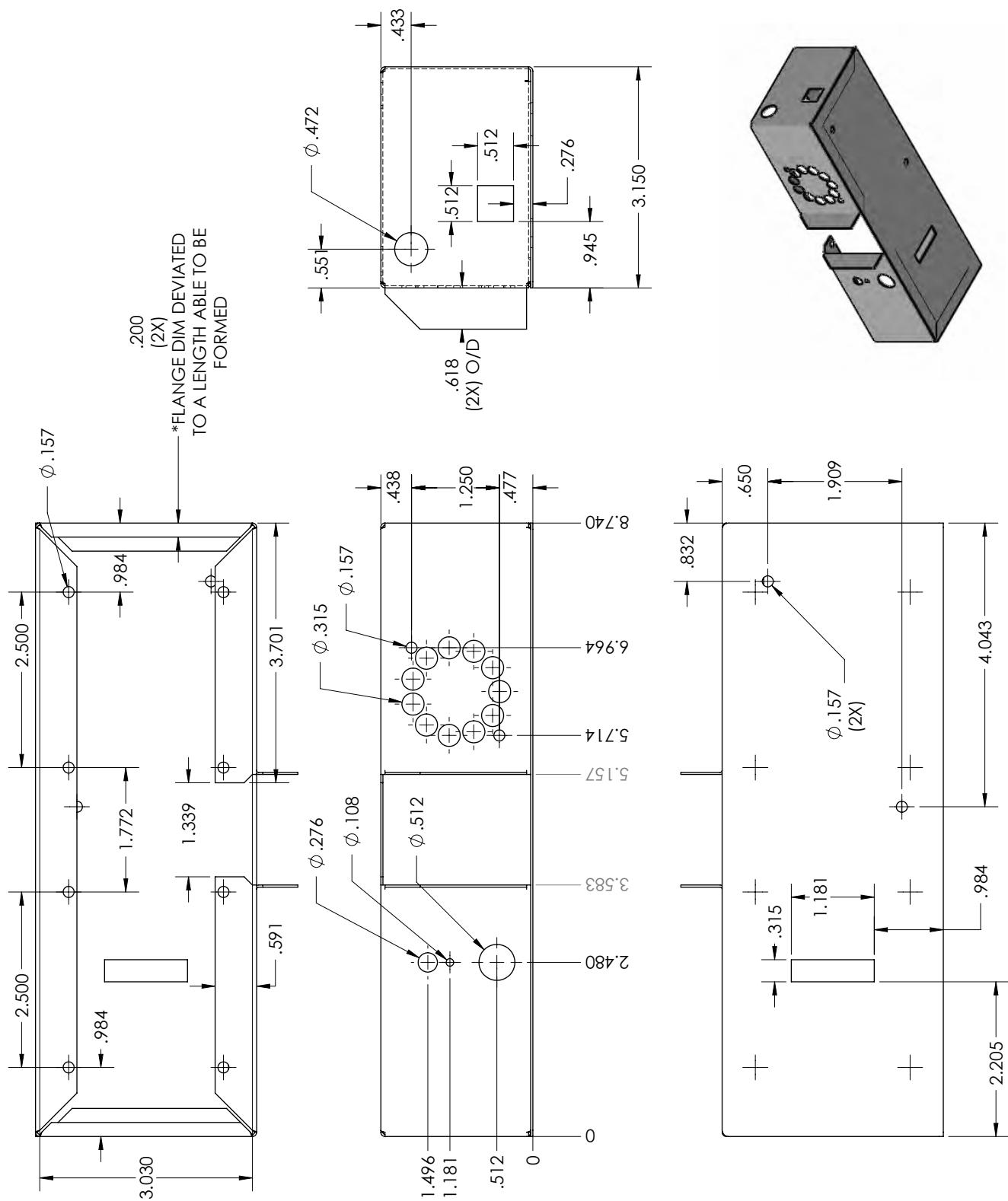
## 2.3 Parts to fabricate

<b>Item to Fabricate</b>	<b>Description</b>	<b>Material</b>	<b># required</b>
Base Box	formed electronics enclosure	16 gauge mild steel sheet	1
Extruder Section	formed metal extrusion head	1/8 in. mild steel sheet	1
Elevator Block	formed metal bracket	16 gauge 1.5 in. square steel tube	1
Machine Riser	vertical post that holds extruder	16 gauge 1.5 in. square steel tube	1
Build Plate	square steel plate with holes for leveling screws	16 gauge mild steel sheet	1
Build Platform	rectangular steel plate with mounting holes	1/8 in. mild steel sheet	1
Piston	notched stainless tube section	1/2" OD, 0.049" wall stainless tube	1
X and Y Rails	machined extruded aluminum rail sections	80 mm wide aluminum linear rail from IGUS	2
Z Rail	machined extruded aluminum rail section	40 mm wide aluminum linear rail from IGUS	1

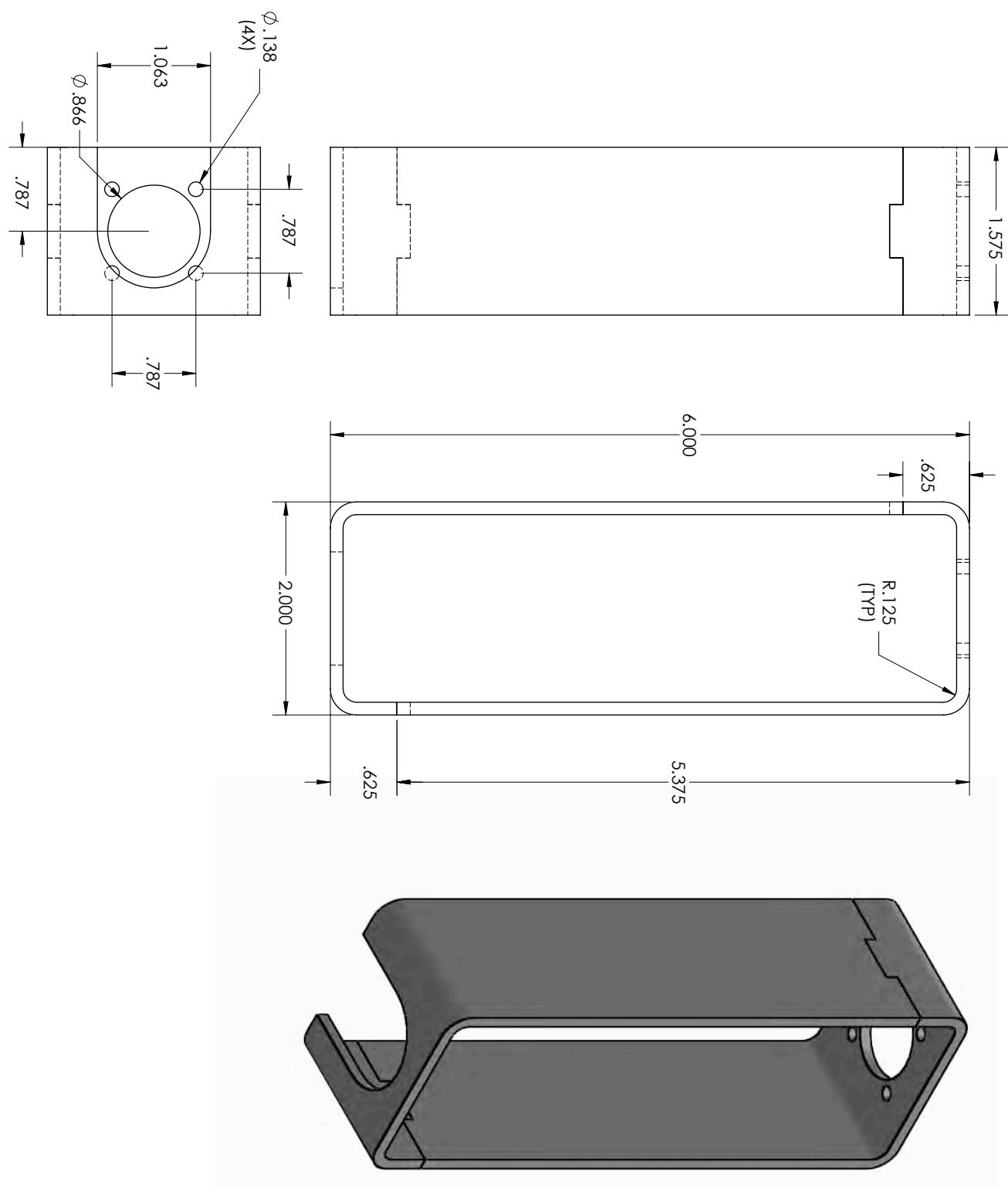


Linear motion rails from IGUS, machined with holes for stepper motor and mounting screws.

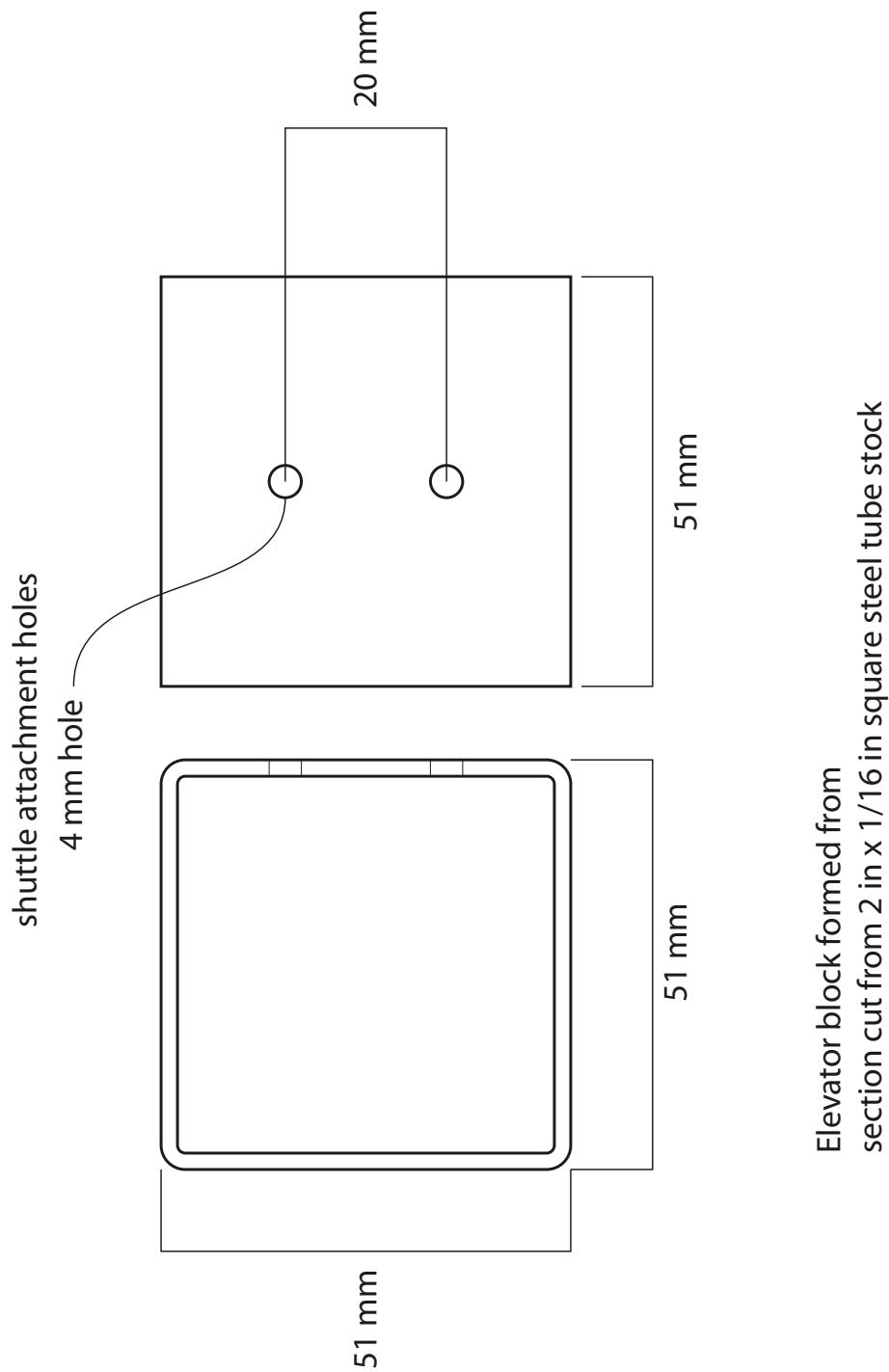
## 2.3 Parts to fabricate: Base Box



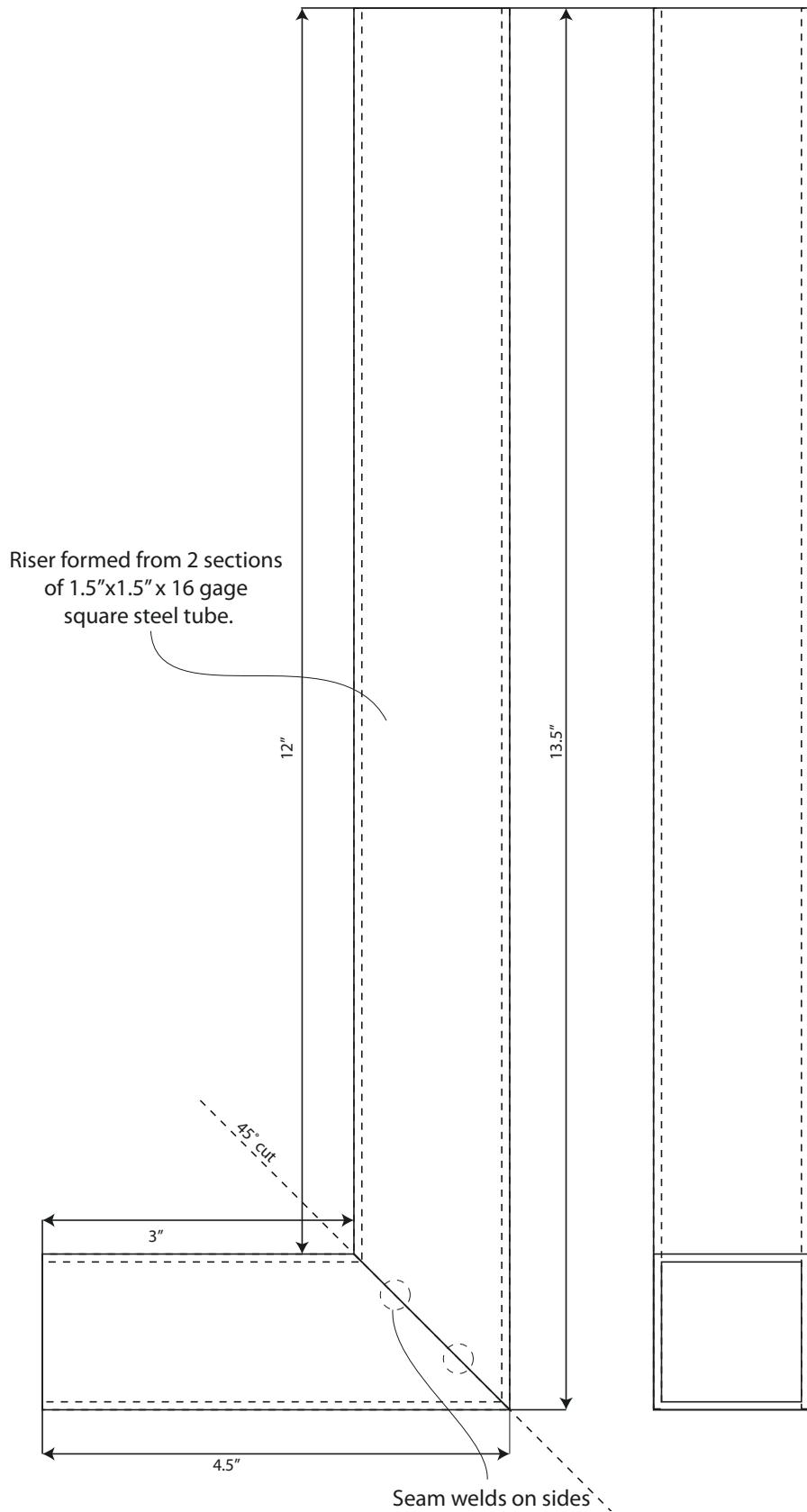
## 2.3 Parts to fabricate: Extruder Section



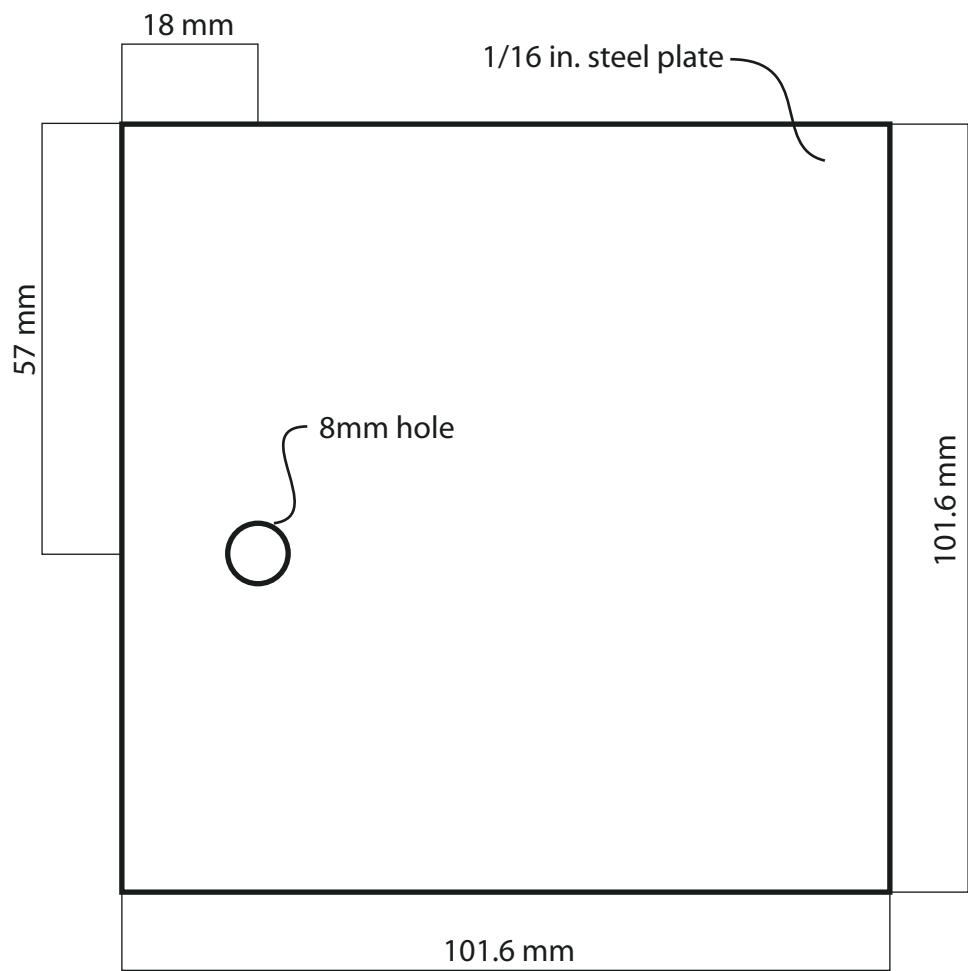
## 2.3 Parts to fabricate: Elevator Block



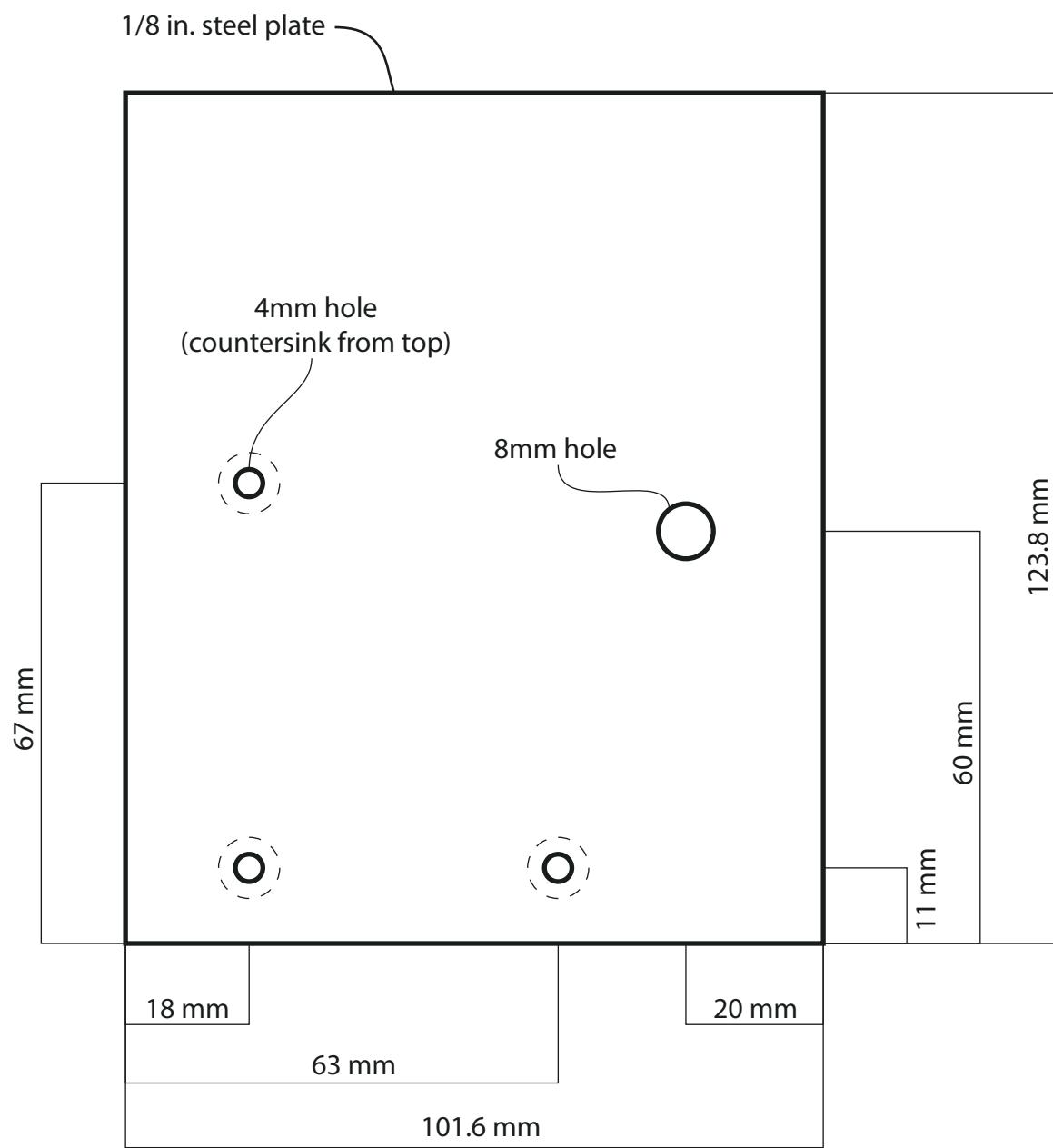
## 2.3 Parts to fabricate: Machine Riser



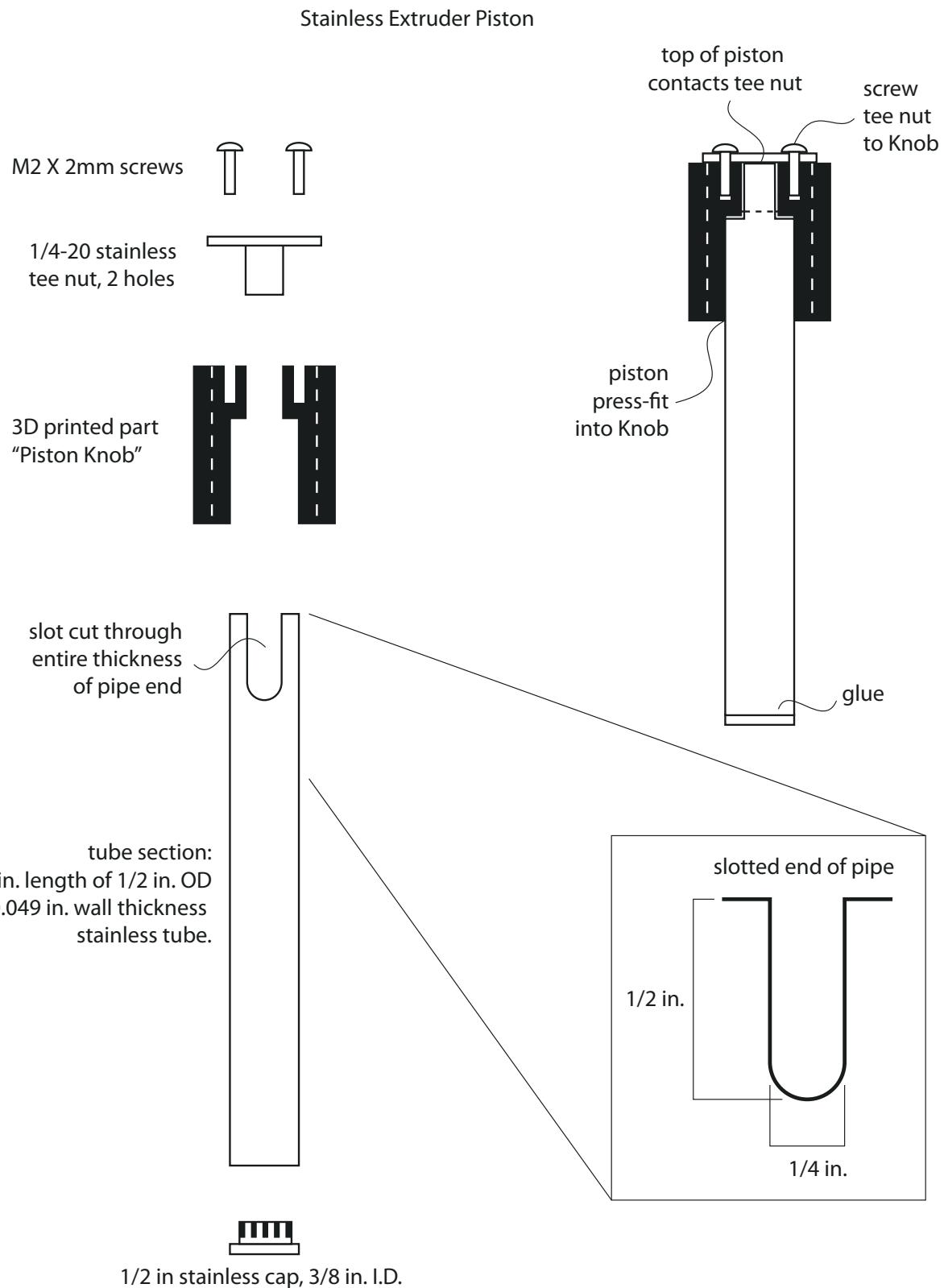
## 2.3 Parts to fabricate: Build Plate



## 2.3 Parts to fabricate: Build Platform

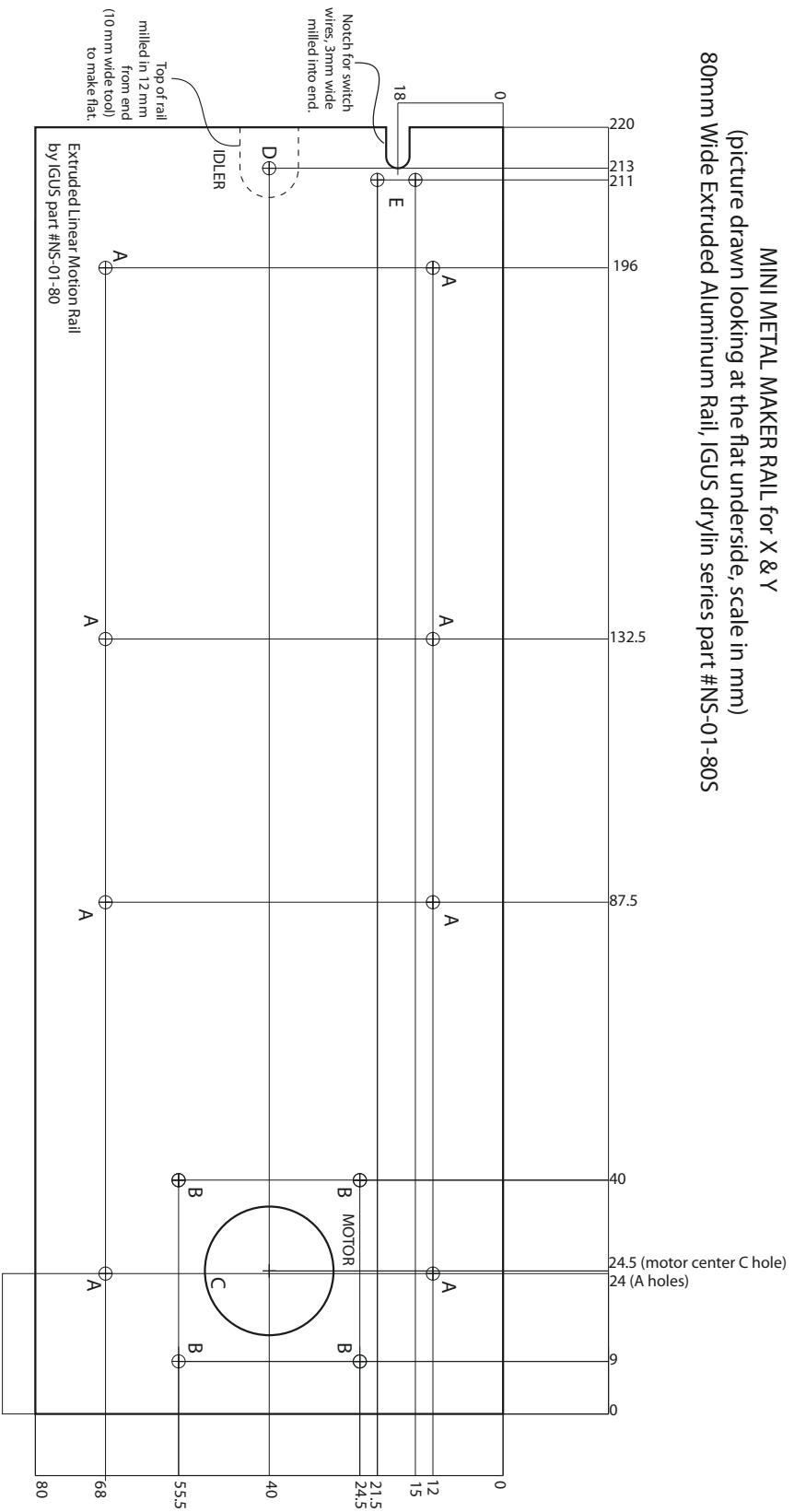


## 2.3 Parts to fabricate: Piston



## 2.3 Parts to fabricate: X & Y Rails

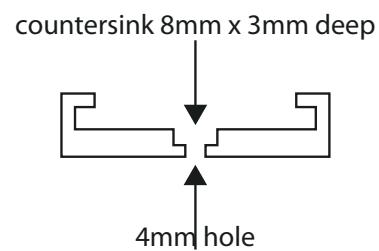
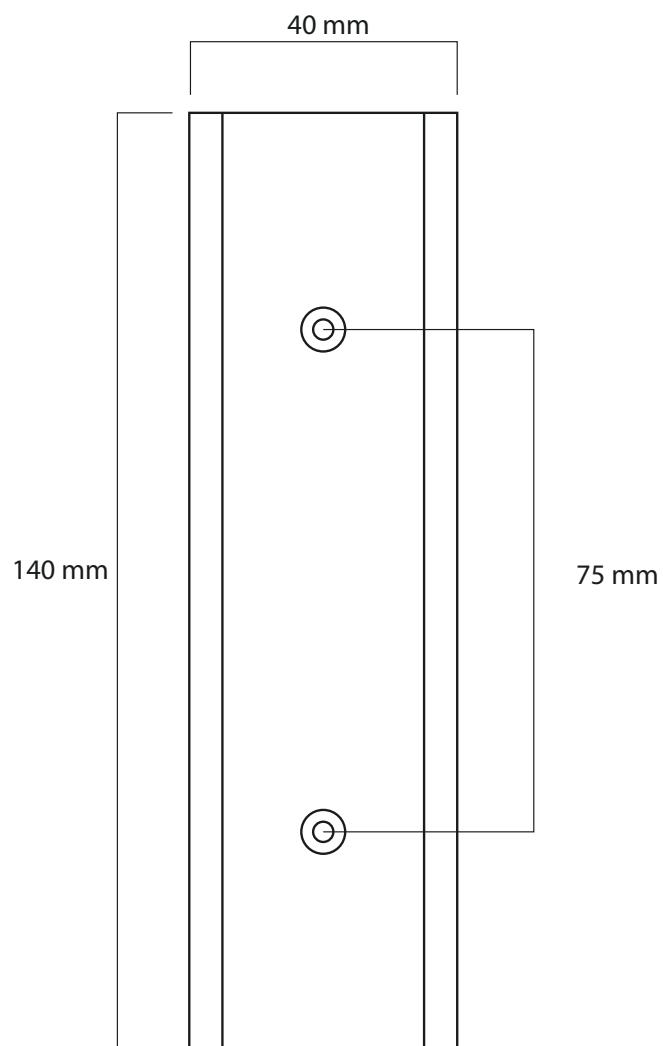
**MINI METAL MAKER RAIL for X & Y**  
 (picture drawn looking at the flat underside, scale in mm)  
**80mm Wide Extruded Aluminum Rail, IGUS drylin series part #NS-01-80S**



## 2.3 Parts to fabricate: Z Rail

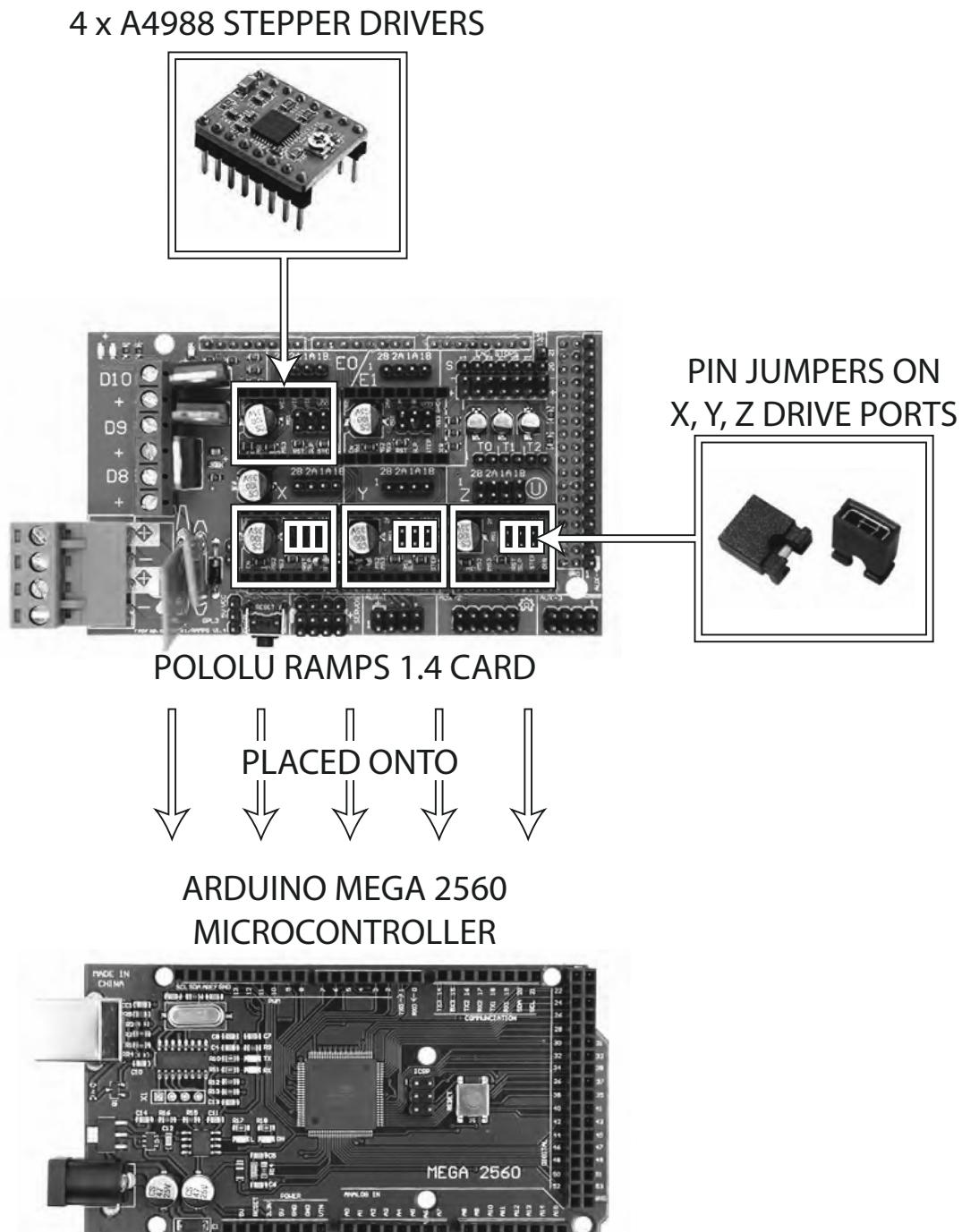
Z - Rail Dimensions

MINI METAL MAKER RAIL for Z  
(picture drawn looking at the flat underside, scale in mm)  
40mm Wide Extruded Aluminum Rail, IGUS Drylin series part # NS-01-40



### 3.1 Assemble microcontroller unit

1. Place 3 pin jumpers on RAMPS board in XY&Z driver sockets to enable substepping.
2. Insert 4 X A4988 stepper driver chips into RAMPS card.
3. Place the RAMPS card onto the Arduino board.



### 3.1 Assemble microcontroller unit

1. Wire lengths and connector configurations for wiring harnesses for all electronic subsystems.
2. Refer to section 4.1 Electronics Overview section for more details about where these wiring harnessses are used.

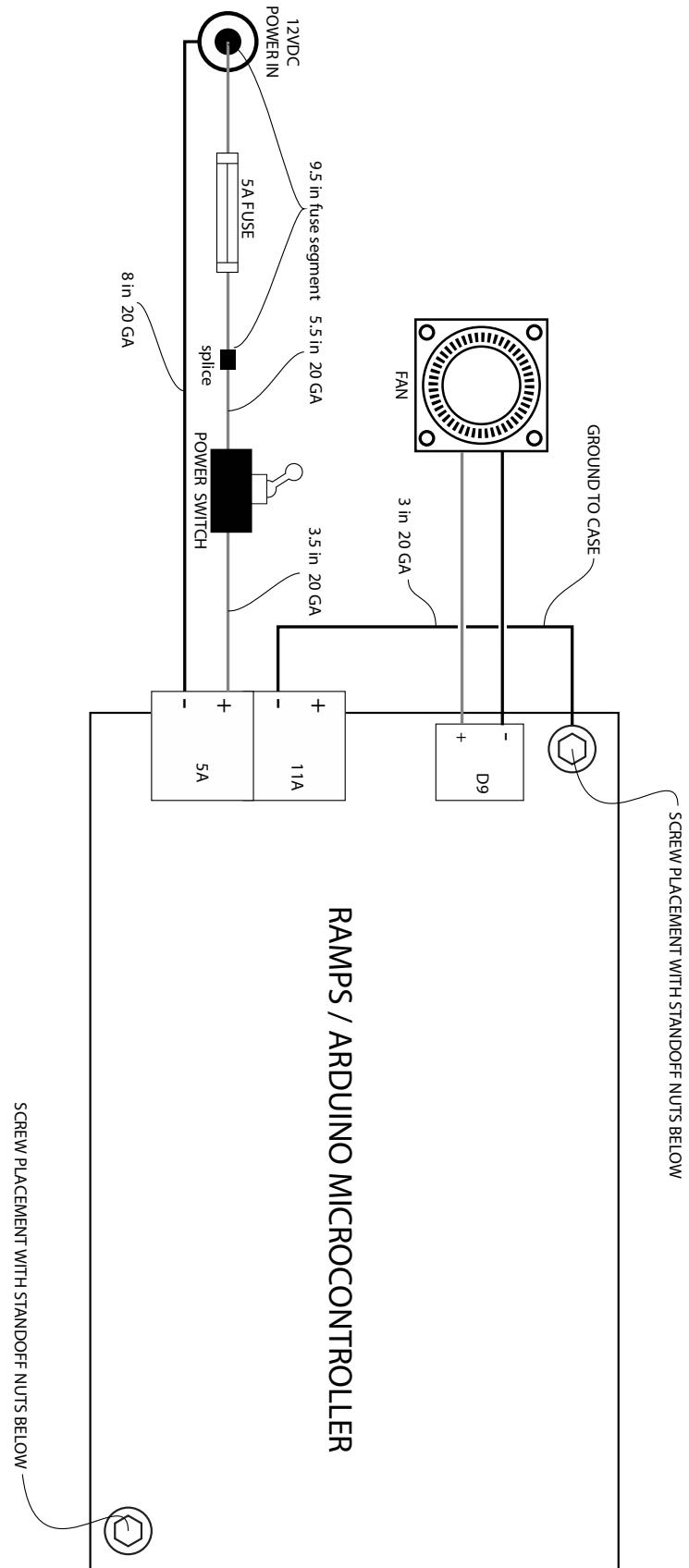
Cable Name	Length (inches)	Wire Size (gage)	Wire Color					Wire endings
			R	G	Blu	Y	Blk	
- POWER	10	20					1	(terminal lugs)
+ POWER	10	20	1					(terminal lugs)
SPEED KNOB	8	26	1		1		1	
Z-MOTOR EXTENSION	30	26	1	1	1	1		
UTILITY POWER	28	24	20	1			1	(terminal lugs)
E-MOTOR EXTENSION	22	26	1	1	1		1	
E-SENSOR	40	26			1	1	1	
Z-ENDSTOP	36	26				2		
Y-ENDSTOP	26	26				2		
X-ENDSTOP	8	26				2		



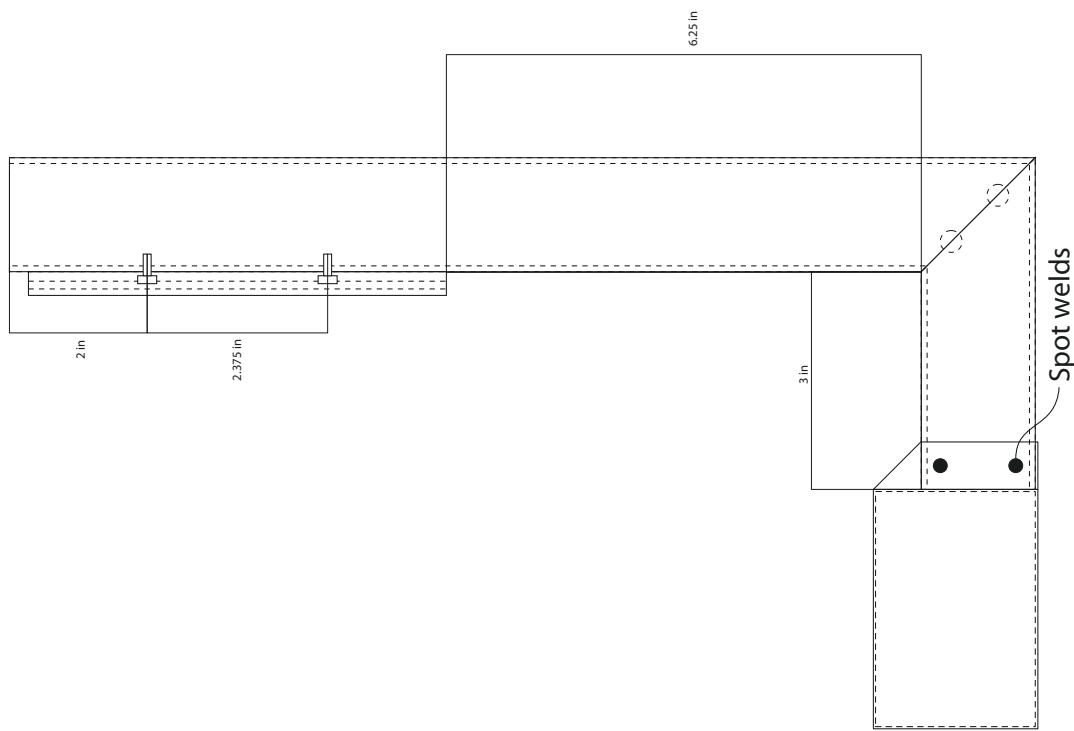
Microcontrol systems with power connections and switches, installed into base boxes of printer assemblies.

### 3.1 Assemble microcontroller and electronics

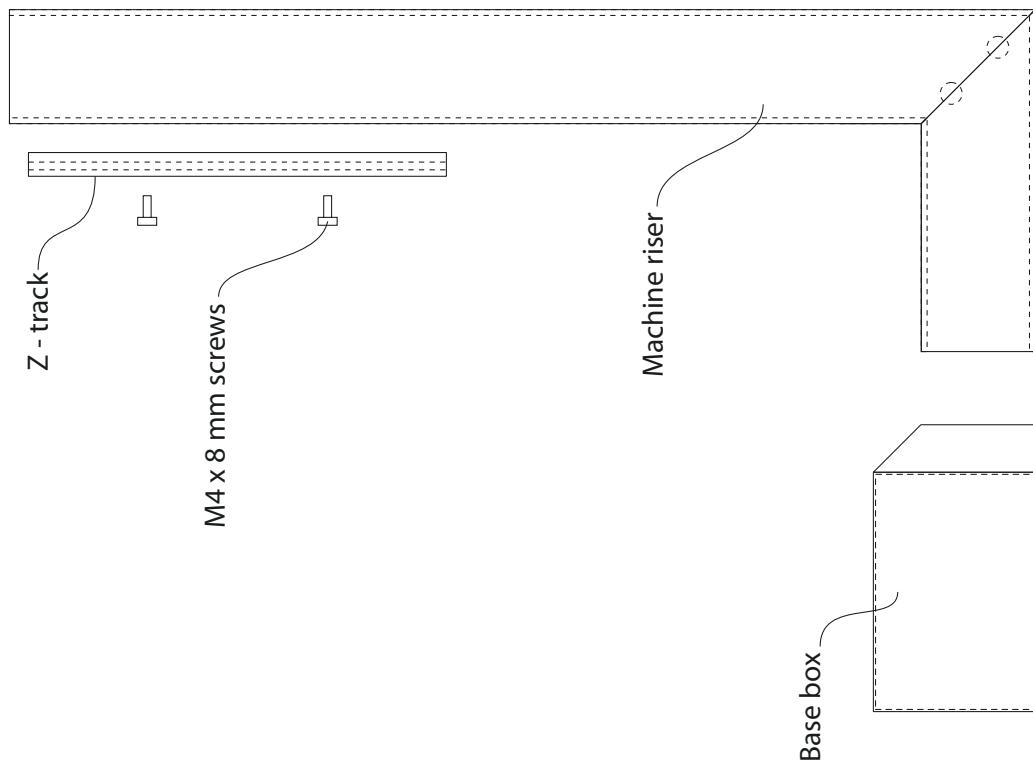
1. Connect fan to RAMPS power output port D9.
2. Create wiring harness containing power connector / fuse / switch.
3. Connect power wiring harness to RAMPS card 5A power input pins.
4. Insert screws with standoffs into RAMPS for installation into base box.
5. Tie RAMPS ground (negative pin from 11A pwr input) to mounting screw head as shown in image.



### 3.2 Assemble machine body

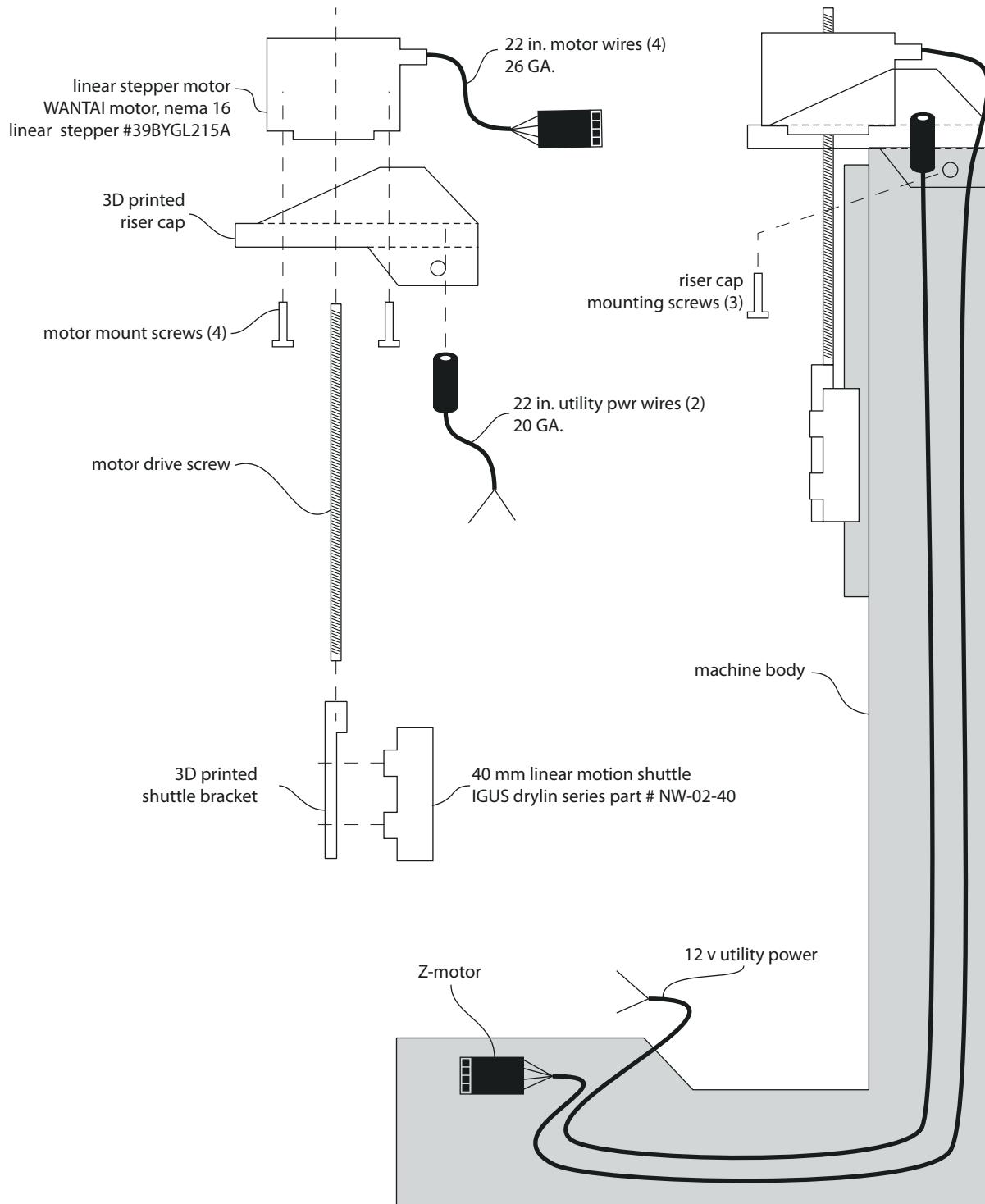


1. Weld riser post into base box.
2. Put X-Track onto riser post using mounting screws.



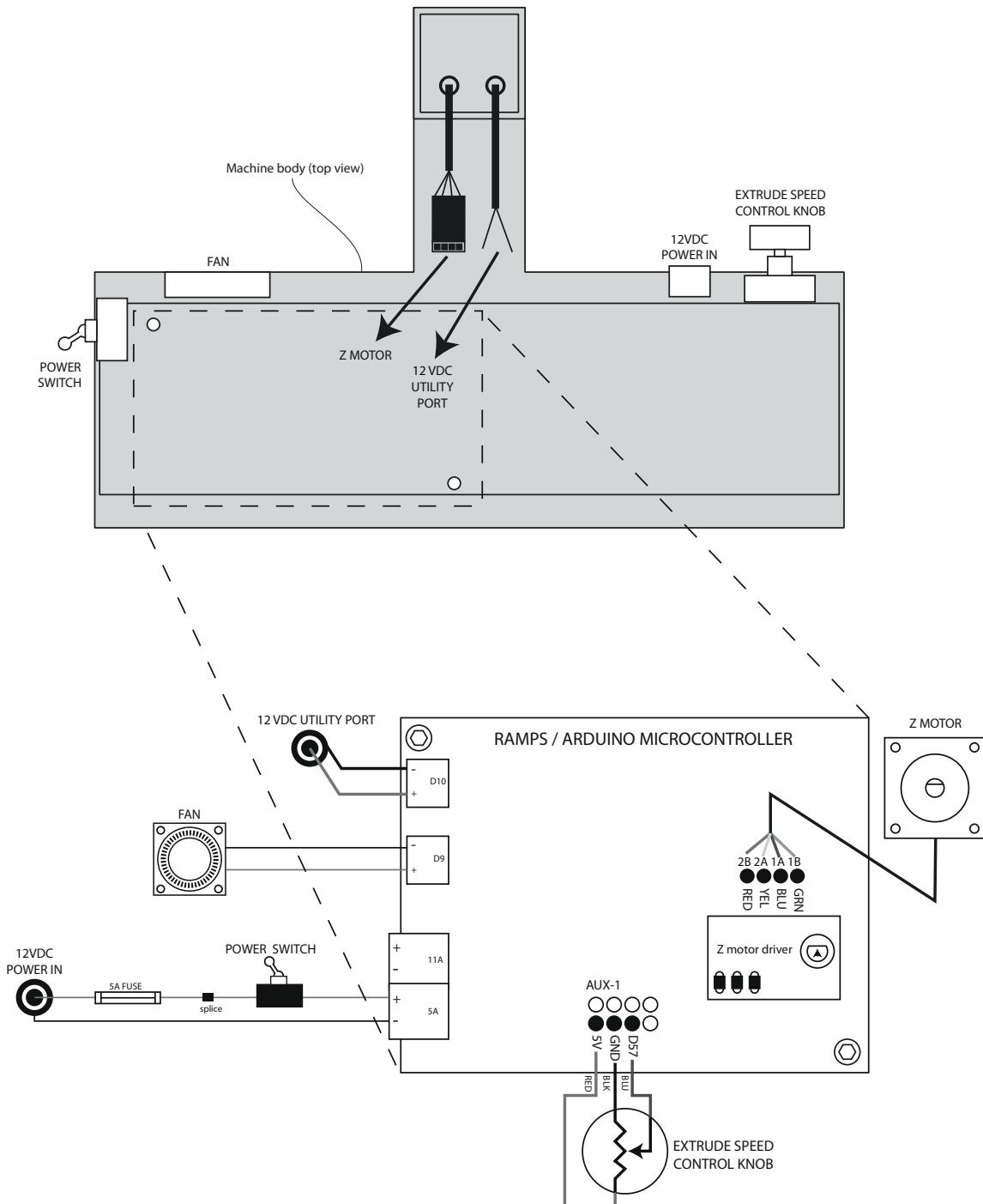
### 3.2 Assemble machine body

1. Bolt z-motor into riser cap, utility power jack in riser cap.
2. Run motor and utility power wires down into base box.
3. Insert motor screw into shuttle brakcket, attach to shuttle, slide shuttle down into z-track.
4. Bolt riser cap onto machine riser.



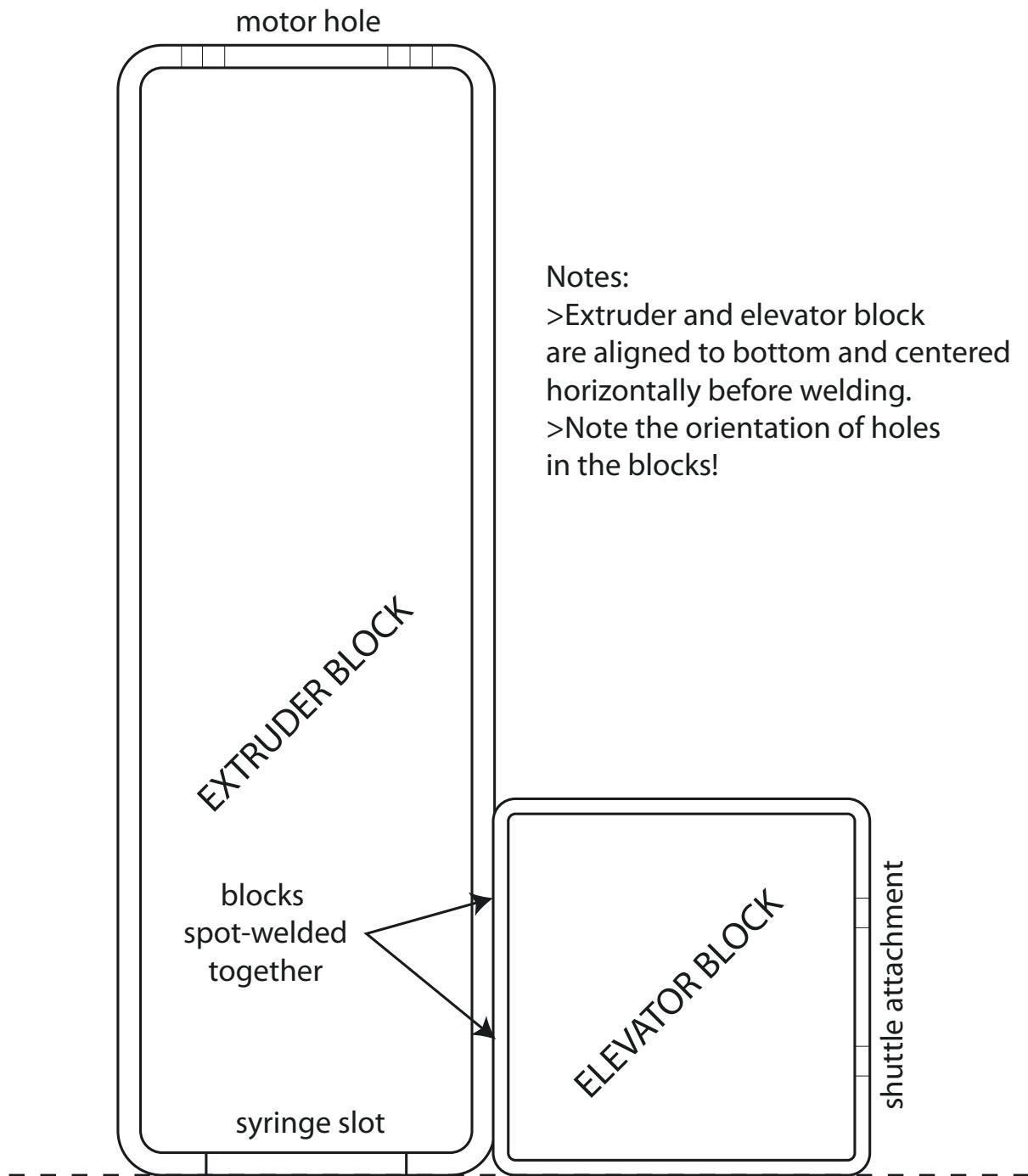
### 3.2 Assemble machine body

1. Install microcontroller.
2. Install speed knob and connect to RAMPS board, AUX-1 pins.
3. Install fan and connect to RAMPS board, D9 power output pins.
4. Install power input jack and connected to RAMPS board, 5A power input pins.
5. Install power switch.
6. Connect utility power wires connected to RAMPS board, D10 power output pins.
7. Connect Z-motor wires to RAMPS board, Z-Motor Driver Output pins.



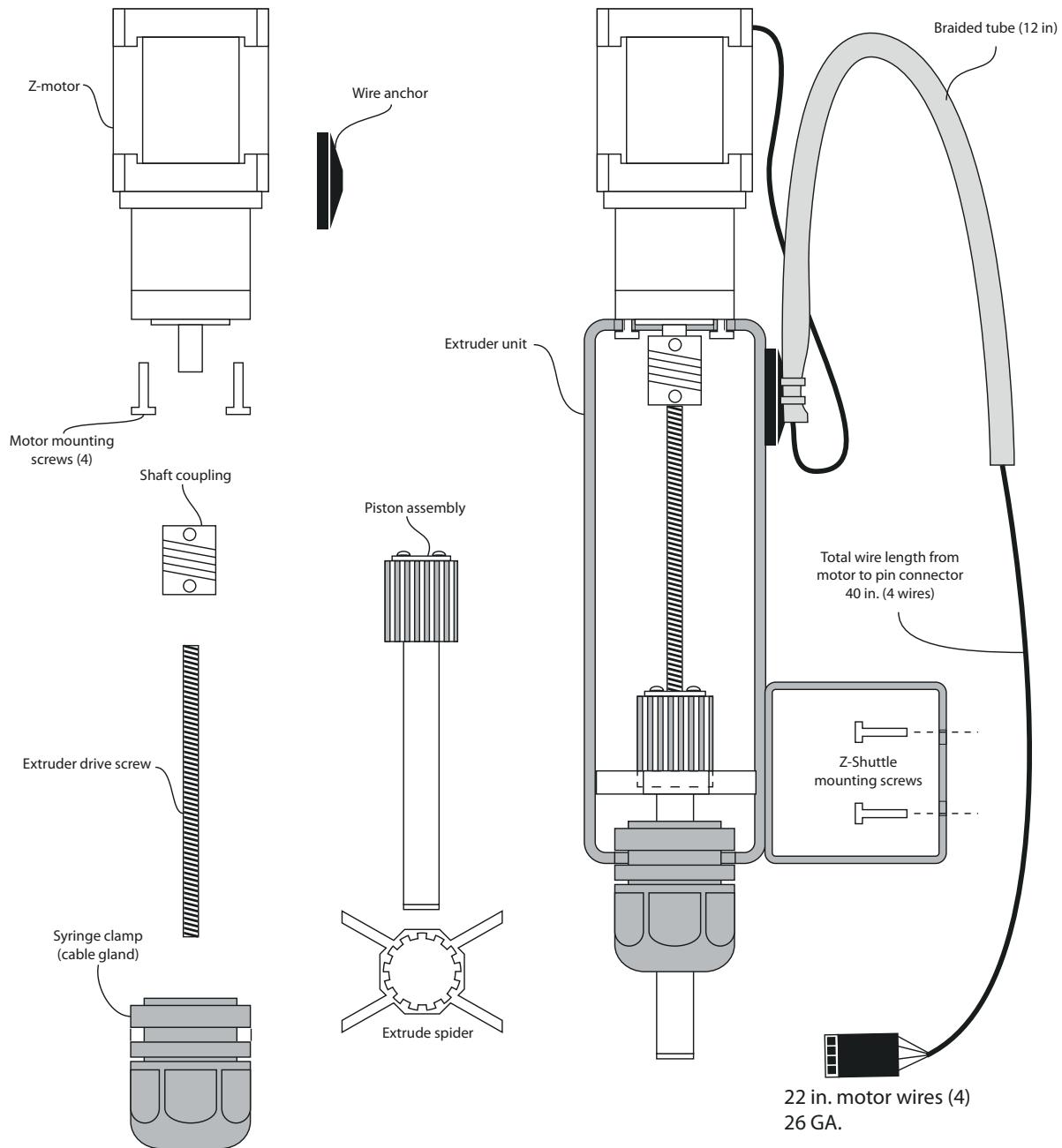
### 3.3 Assemble extruder unit

1. Align Extruder Block and Elevator Block as shown in drawing.
2. Weld Extruder Block and Elevator Block together.

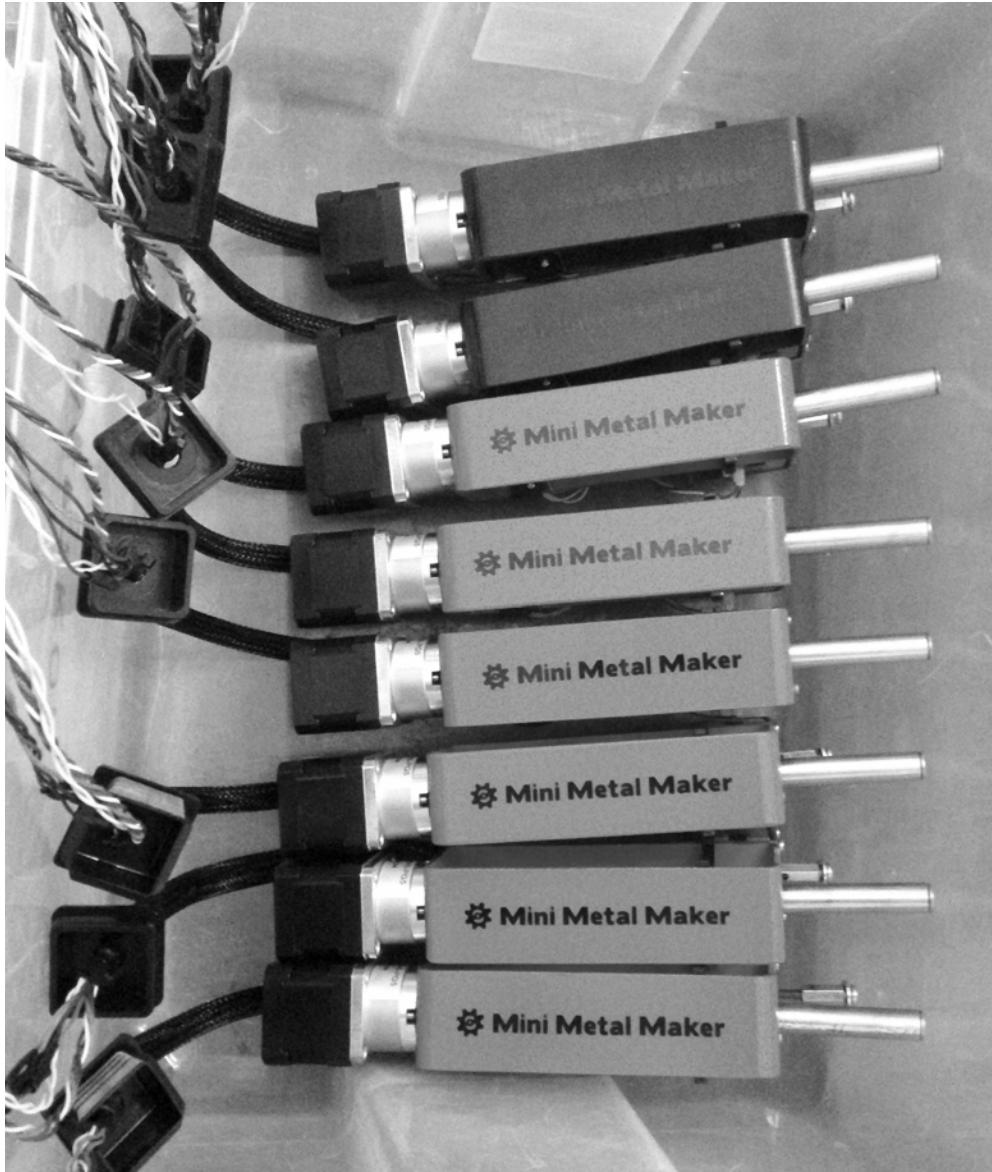


### 3.3 Assemble extruder unit

1. Bolt extruder motor into top hole of extruder block with 4 screws.
2. Use shaft coupling to attach Extruder drive screw to motor shaft.
3. Screw the assembled piston unit onto the drive screw by hand. Secure with the *extrude spider*.
4. Attach cable anchor to extruder block as shown in drawing.
5. Extend motor wires so that they are a total of 22 inches in length.
6. Feed extrude motor wires through 12 inches of braided tube, affix tube to wire anchor.
7. Place 4 pin connector to motor wire. See full system schematic for wire order etc.



### 3.3 Assemble extruder unit

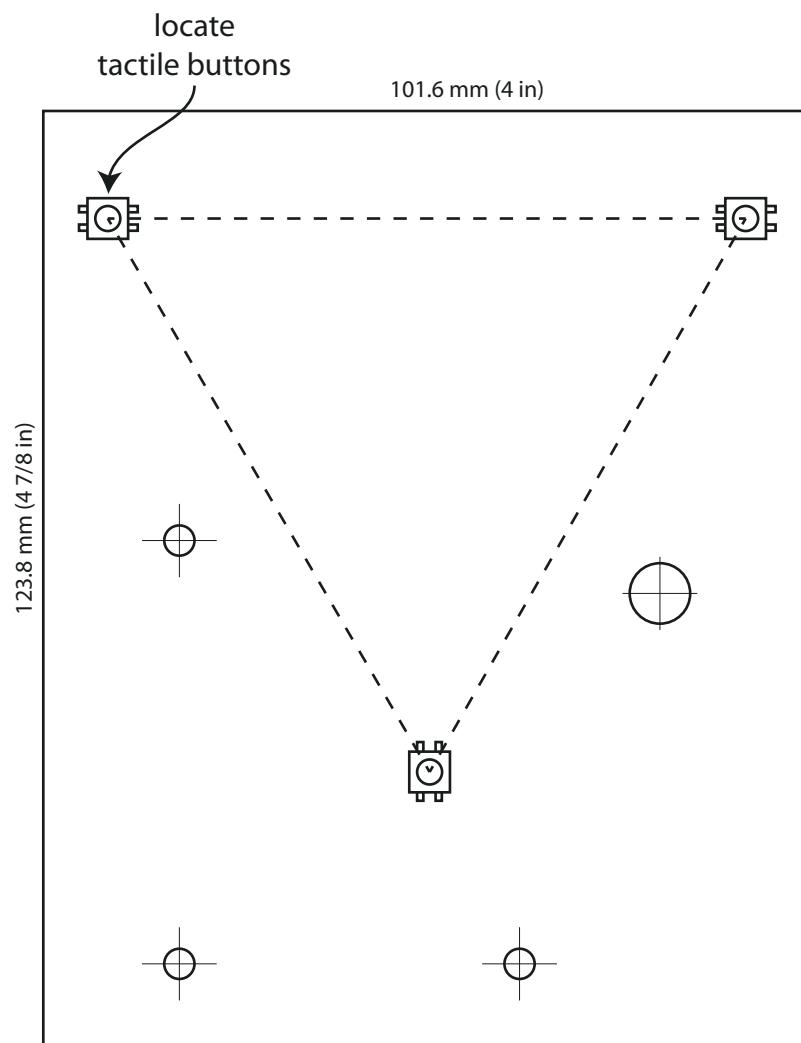


A row of completed extruder unites with endcaps and wiring harnesses.

### 3.4 Assemble Build Plate

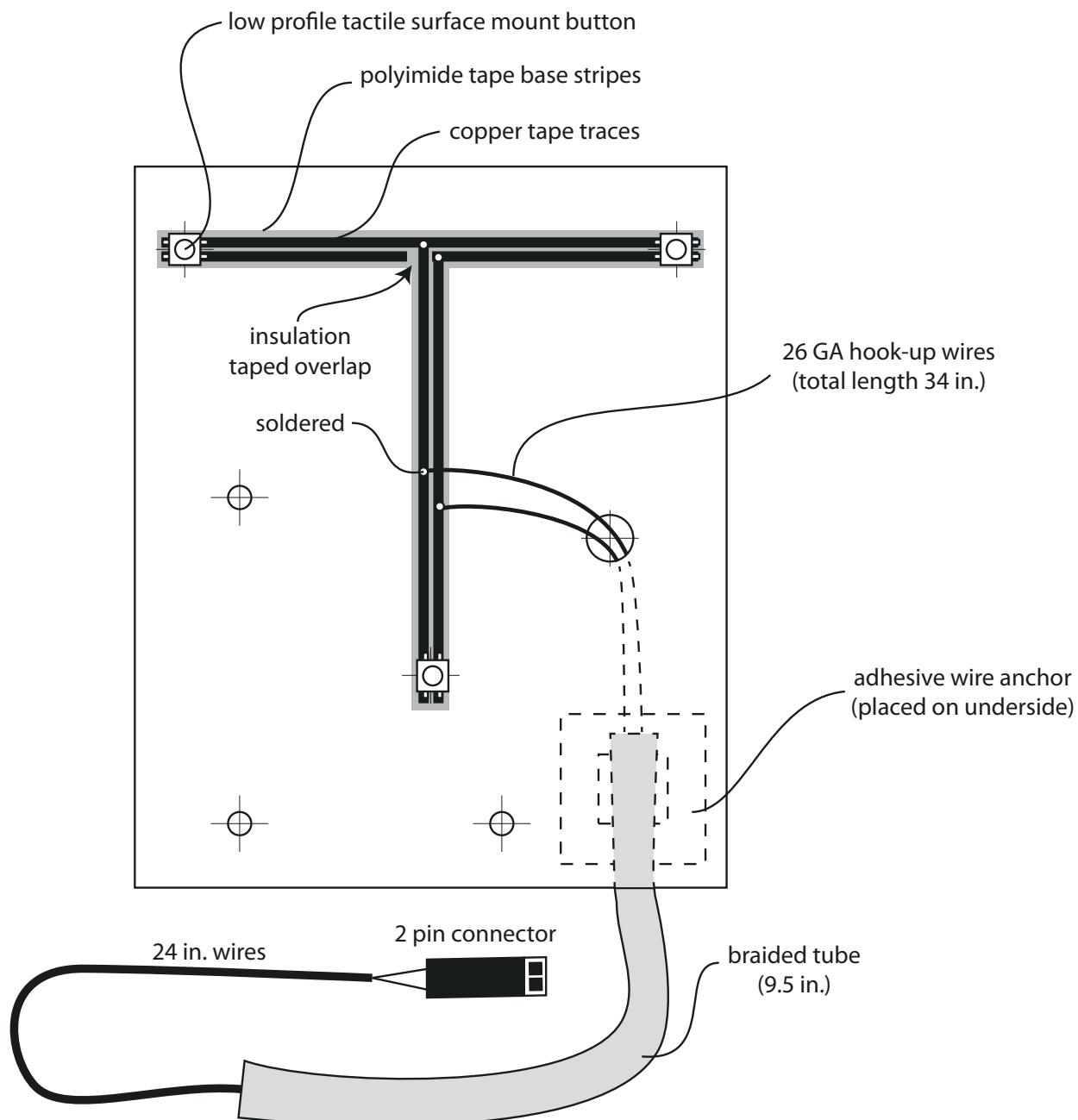
1. Print this template full scale (1:1) scale on paper.
2. Mark button locations through the paper template onto the steel build platform. These three buttons act as a contact sensor for the extruder nozzle of the printer, and together set the lower bound for the Z-Axis motion range.

Template for Locating Tactile Buttons on Build Platform



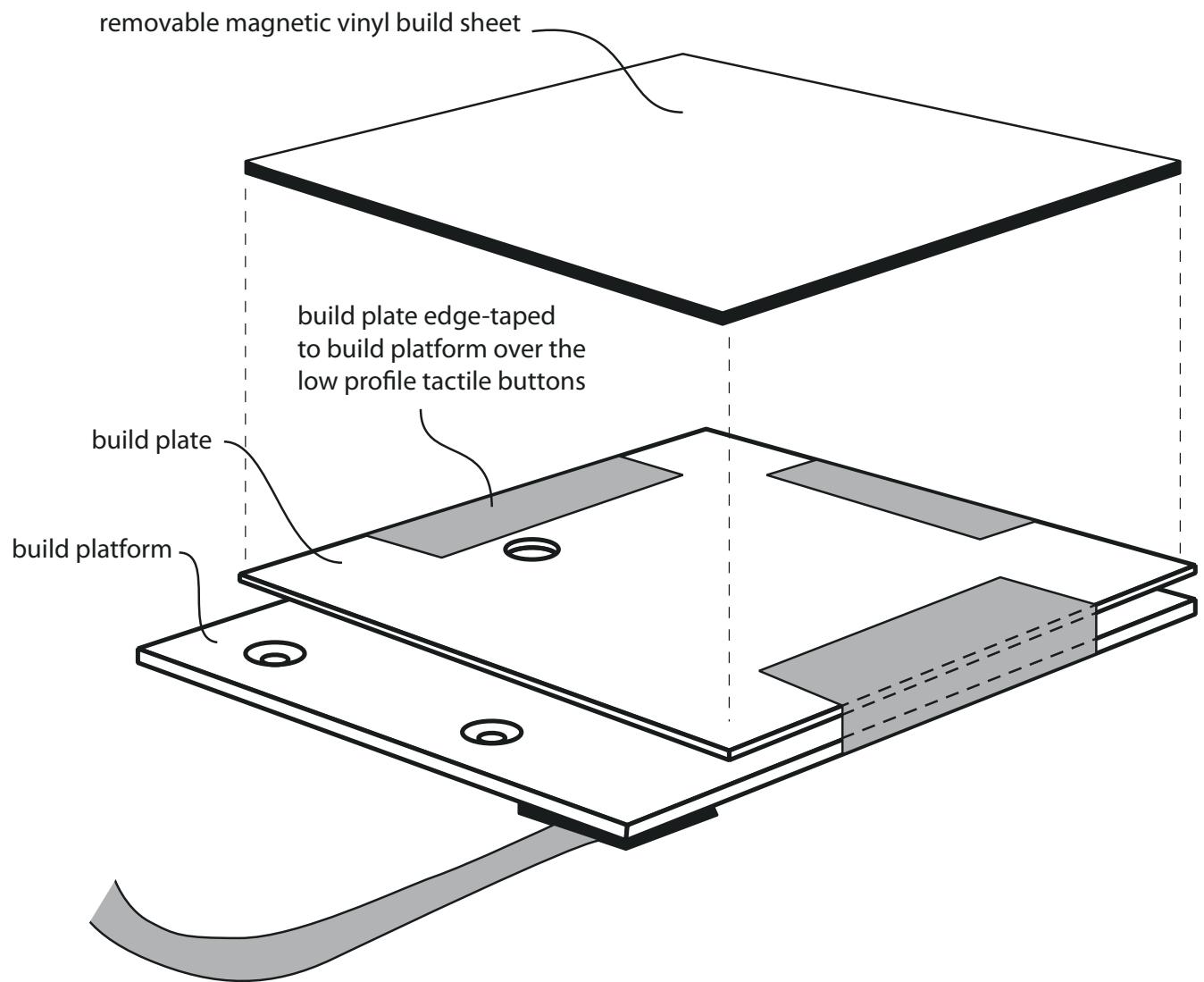
### 3.4 Assemble Build Plate

1. Place "T" pattern of polyimide insulation tape between button locations as shown in the drawing.
2. Place parallel traces of copper tape onto insulation layer as shown in the drawing. Use tape for overlaps.
3. Glue tactile buttons into pre-marked locations on ends of the "T" with superglue.
4. Solder buttons to traces, connect traces of "T" with solder.
5. Run 24 in long hook up wire pair down through 8mm hole in build plate.
6. Run wire pair through 9.5 in of braided tube. Fasten tube to wire anchor on underside as shown.
7. Attach 2 pin connector to end of hook up wires pair.



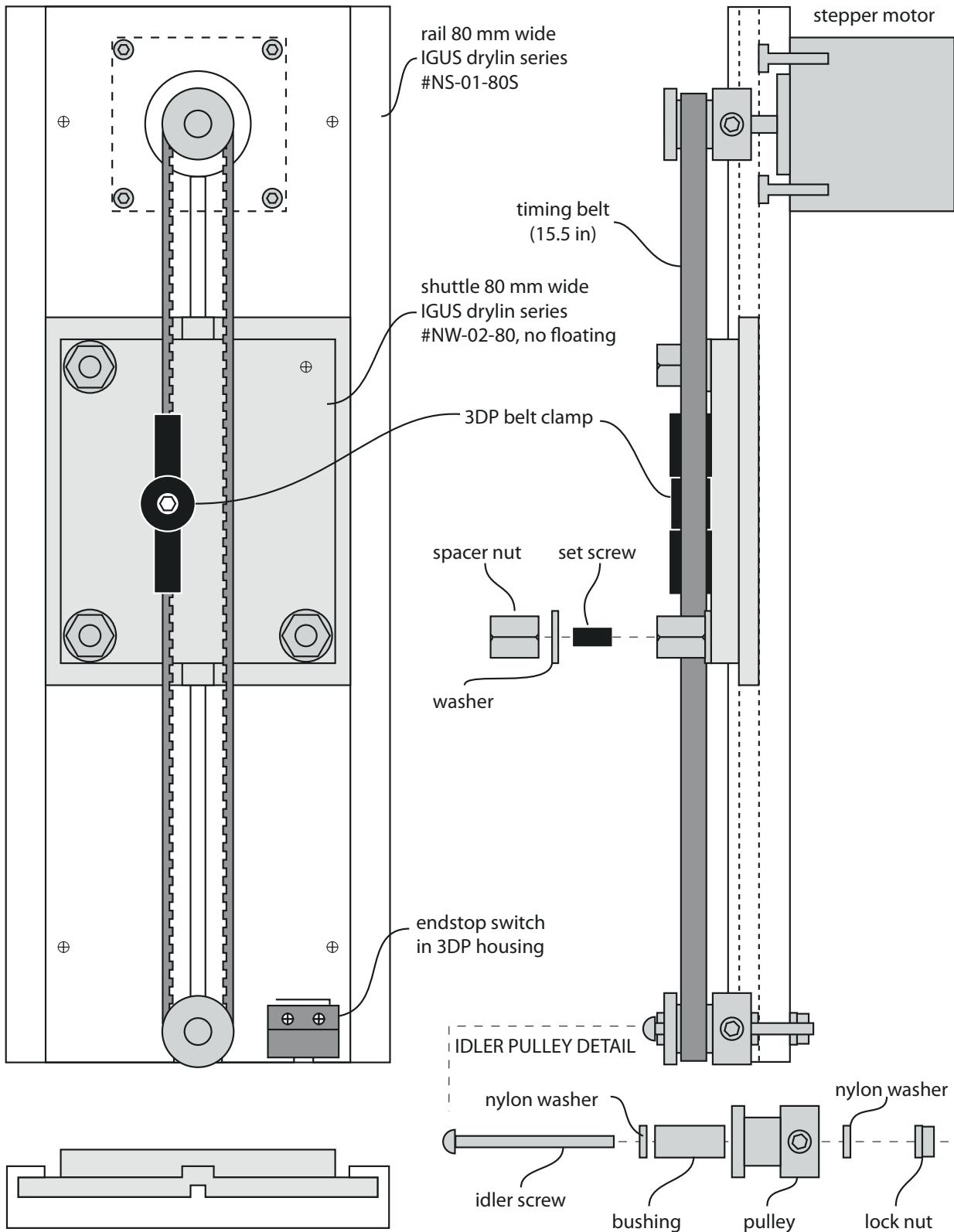
### 3.4 Assemble Build Plate

1. Align build plate on top of tactile buttons on build platform so that 8mm hole lines up with screw hole.
2. Use adhesive polyimide tape to secure build plate to build platform as shown in picture.



### 3.4 Assemble X&Y Track

Assemble two linear-motion systems as shown:



### 3.4 Assemble X&Y Track

1. Slide shuttle onto track.
2. Assemble the idler pulley as shown in image.
3. Install motor in track as shown in the image.
4. Install timing pulley on motor shaft.
5. Bolt 3D printed belt clasp to plate of shuttle as shown (requires drilling + threading hole)
6. Wrap 15.5 in. timing belt (6mm 2mm pitch GT2) around pulley pair, anchored into belt clasp. Use a separate add-on belt tension spring as needed.
7. Mount endstop switch (wired N.C. ) onto track over slot cut near idler pulley.
8. Attach spacer nuts to shuttle using 8 mm set screws as shown. Use loctite or super glue to stop.

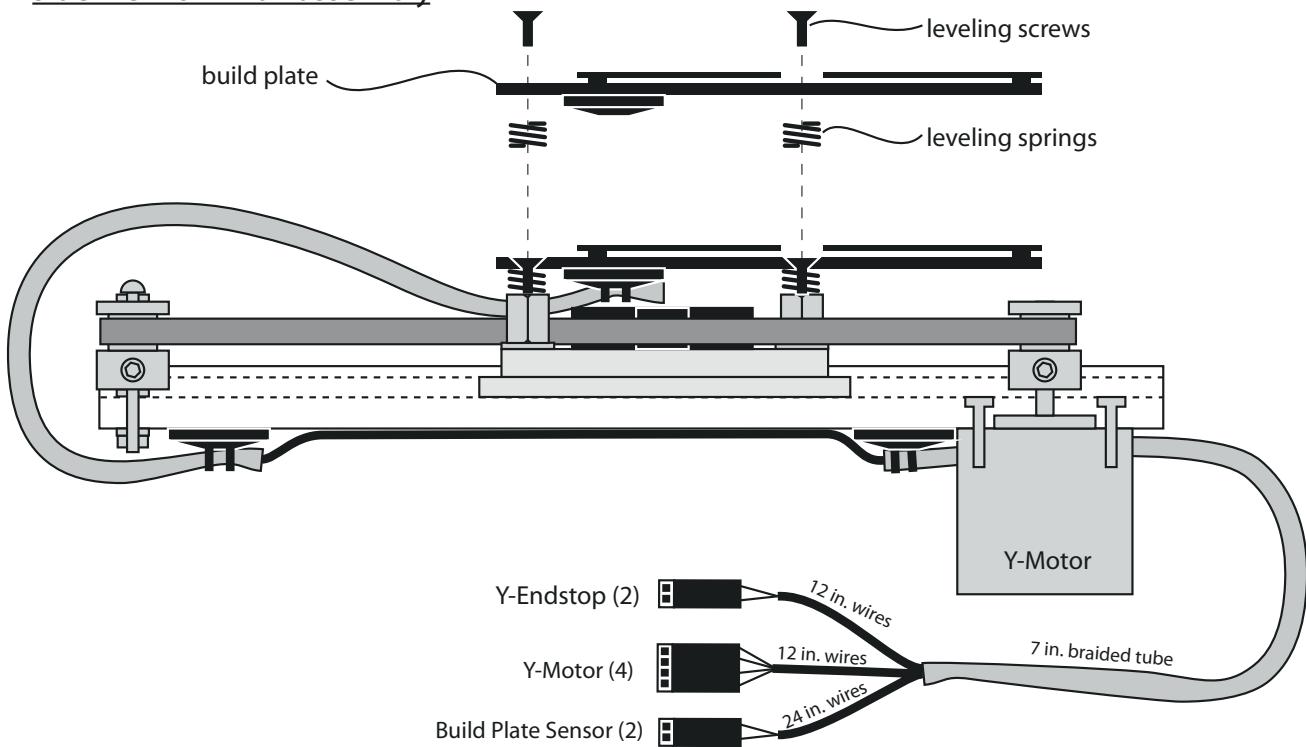
Note: IGUS drylin shuttles glide on polymer inserts in a metal shuttle. If there is too much wobble, spacing can be tightened by placing vinyl or polyimide tape layers onto metal shuttle below the polymer inserts.



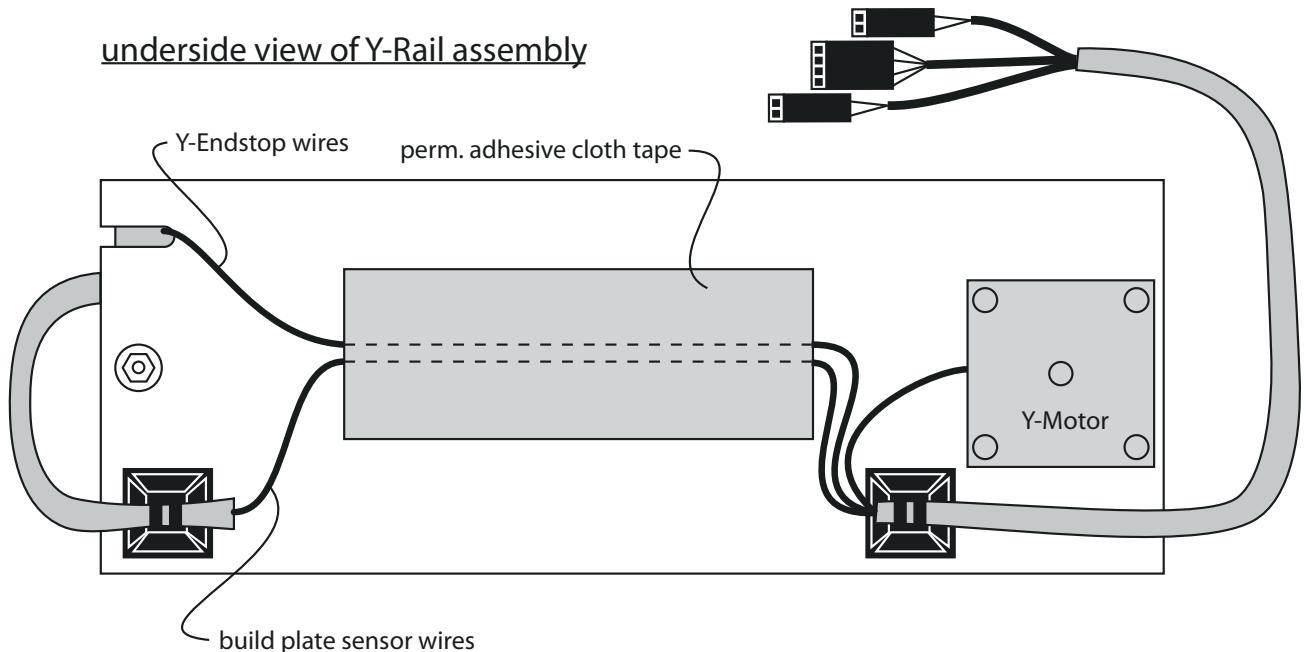
*Linear motion rails assembled with motors, shuttles, timing pulleys.  
These units are used for both the X and Y linear motion systems.*

### 3.4 Build Plate onto Y-Rail

side view of Y-Rail assembly



underside view of Y-Rail assembly

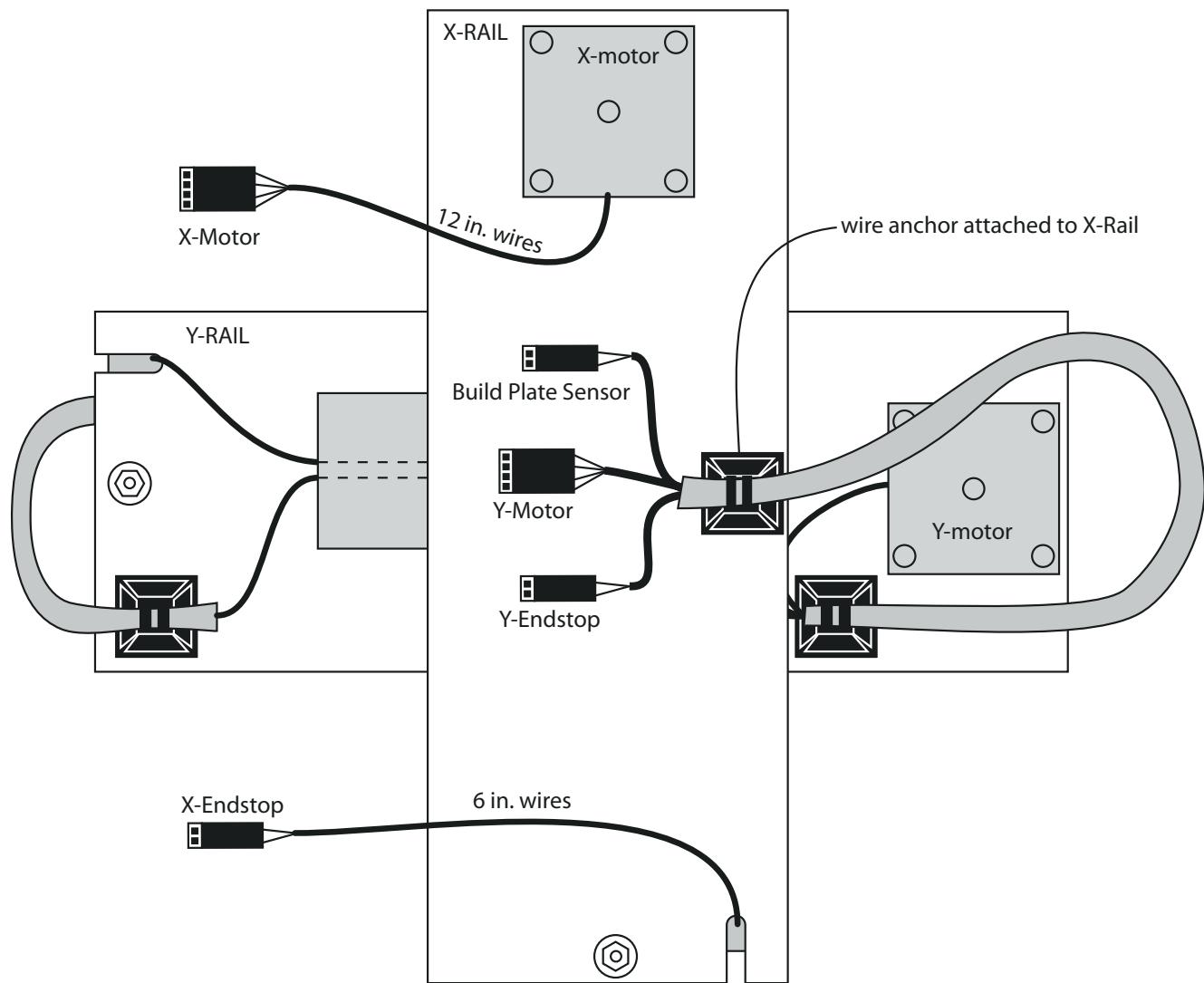


### **3.4 Build Plate onto Y-Rail**

1. Mount build plate with screws through springs into spacer nuts on Y-Shuttle.
2. Anchor build plate braided tube to underside of Y- Track.
3. Secure wires from Build Plate and Y-Endstop to underside of track using tape as shown in picture.
4. Bundle wires from Build Plate, Y-Endstop and Y-Motor into 7 in. of braided tube.
5. Anchor braided tube to underside of Y-Track near Y-Motor as shown.

### 3.4 Y-Rail onto X-Rail

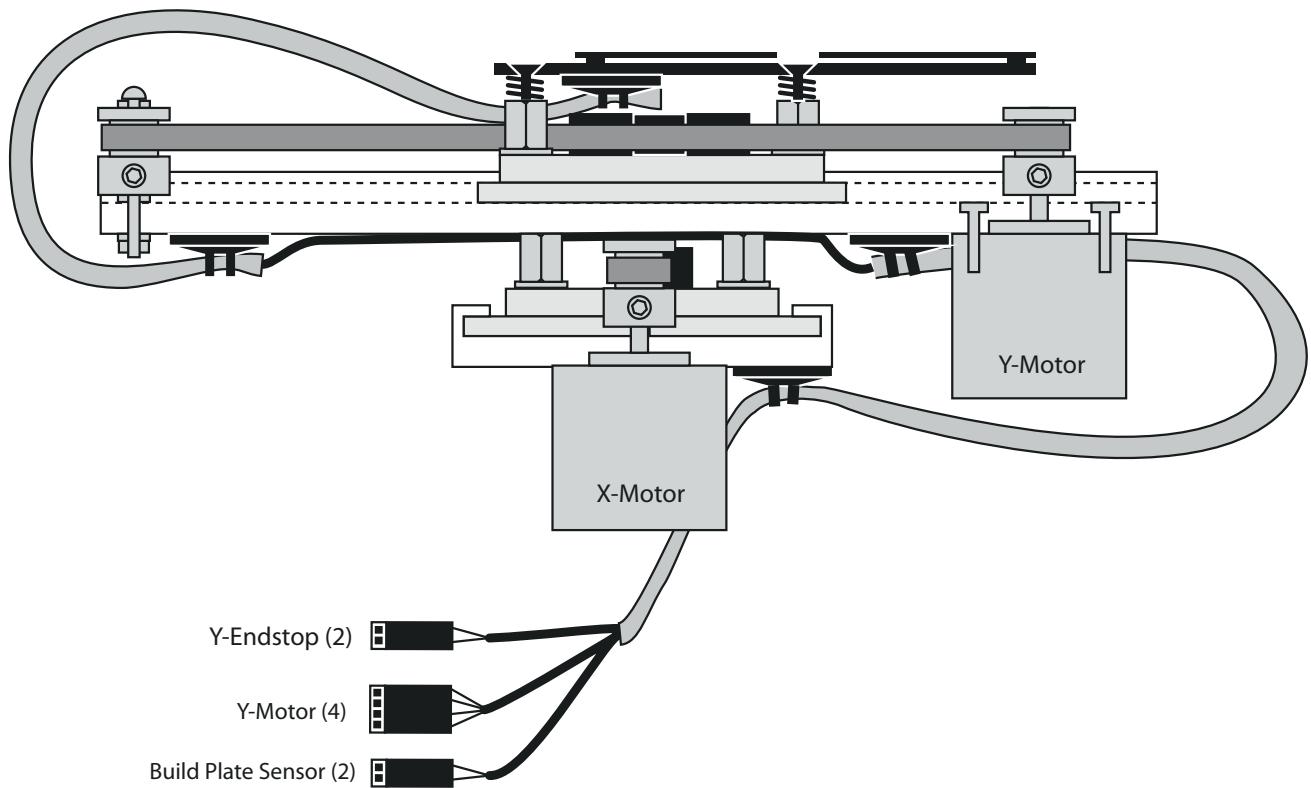
underside view of X/Y rails assembly



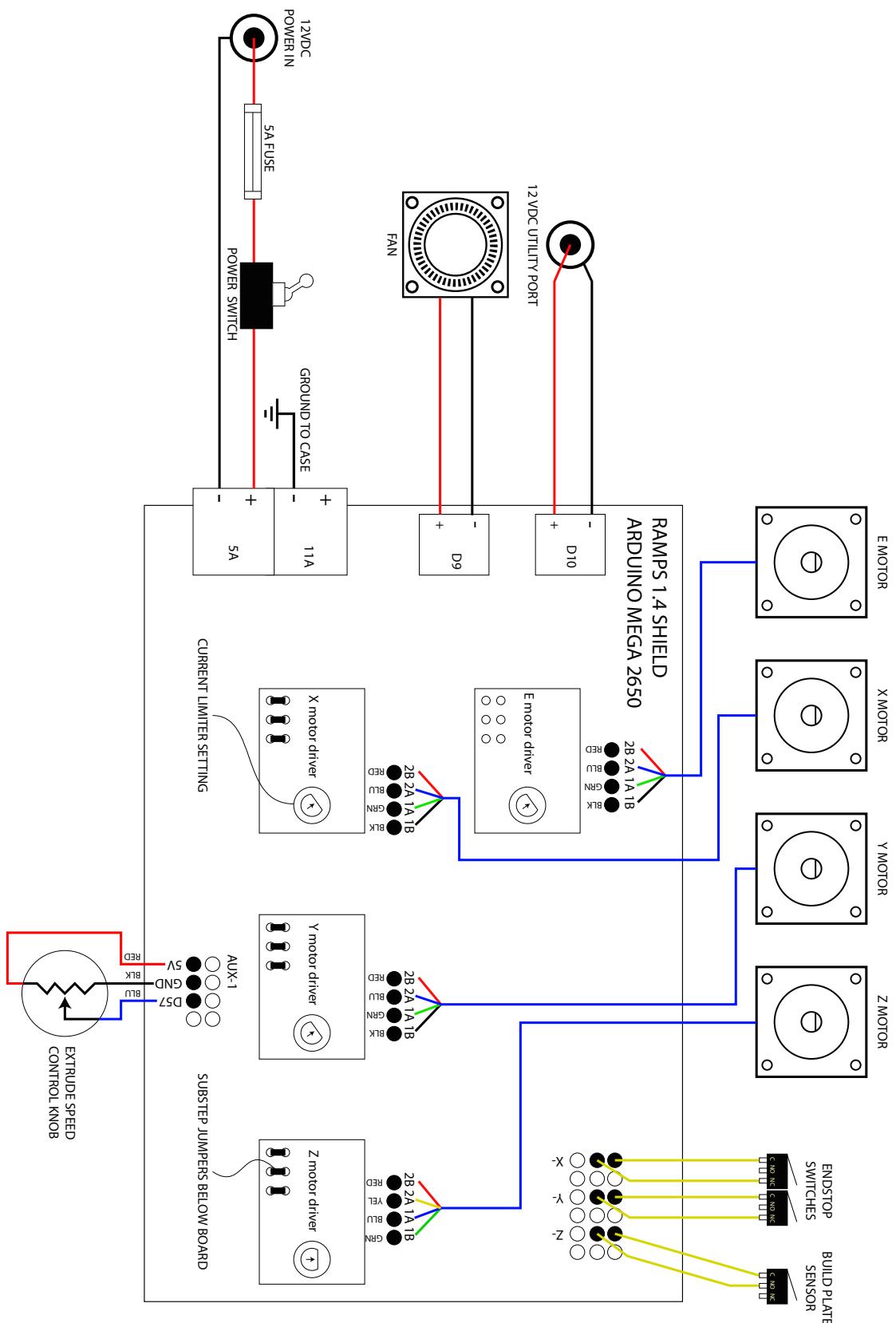
### 3.4 Y-Rail onto X-Rail

1. Use adhesive wire anchor to attach braided tube from Y-Track to X-Track.
2. Align tracks at 90 degrees as shown on previous page.
3. Use 3 screws to bolt Y rail into spacer nuts of X-Shuttle as shown in drawing below.

side view of X/Y rails assembly



Electrical schematic for Mini Metal Maker Pro



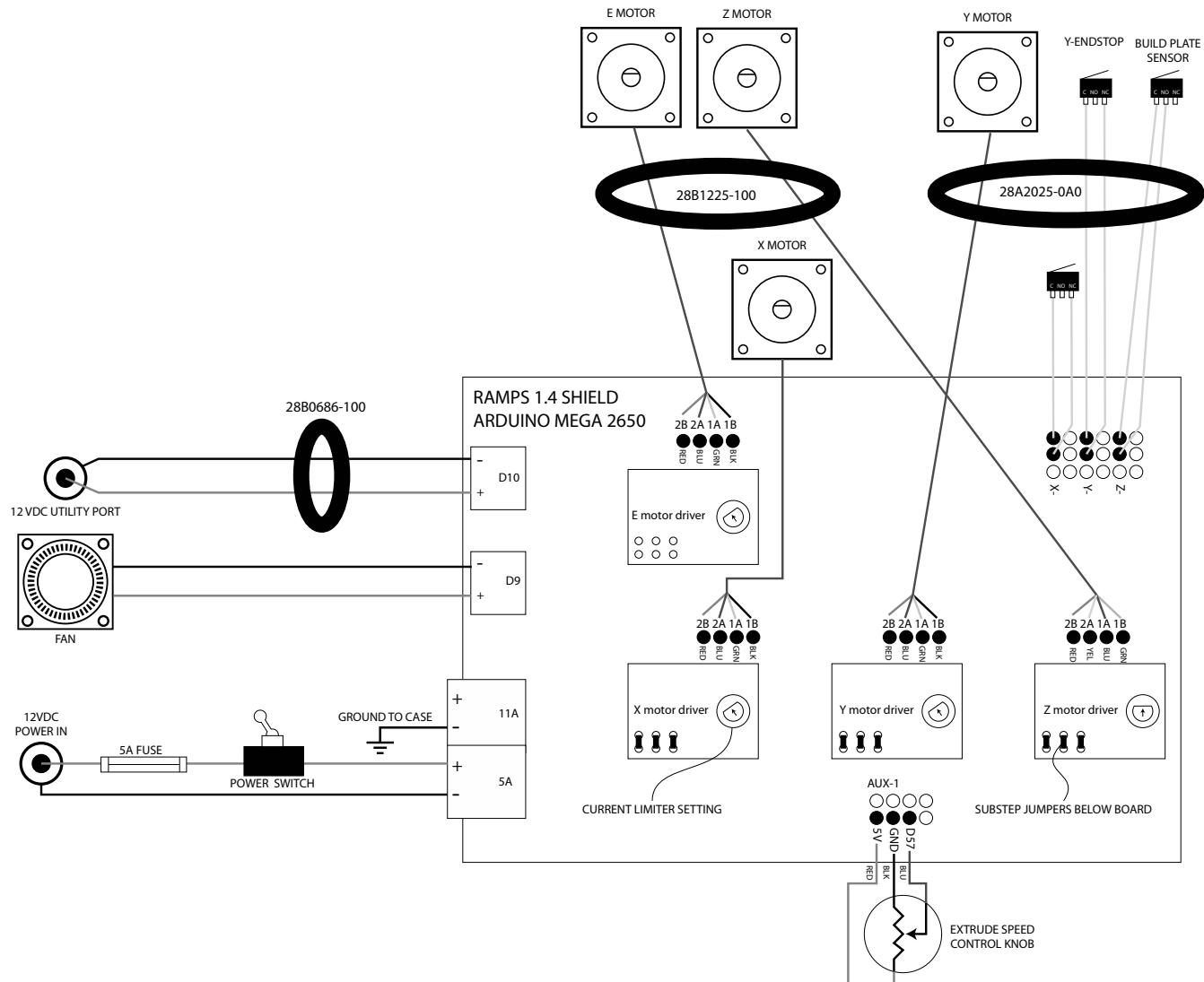
#### 4.1 Electronics system overview

## 4.1 Electronics system overview

Type and locations of ferrite inductors required for EMF compliance with U.S. FCC.

Inductors to Order for FCC compliance  
Ordered from Mouser Electronics, [www.mouser.com](http://www.mouser.com)

Item	Part No.	For what parts
Ring Ferrite	28B1225-100	Z & E Motors & pwr input
Ring Ferrite	28B0686-100	Utility Pwr Output
Clamp-on Ferrite	28A2025-0A0	Y motor, Y endstop, Z endstop
Clamp-on Ferrite	28A0592-0A2	Power Supply Cable
Clamp-on Ferrite	28A0593-0A2	USB Cable



## 4.2 Final Assembly Guidelines

1. Feed Extruder Unit wires down riser through slot in riser cap.

2. Attach extruder unit to machine riser with two screws.

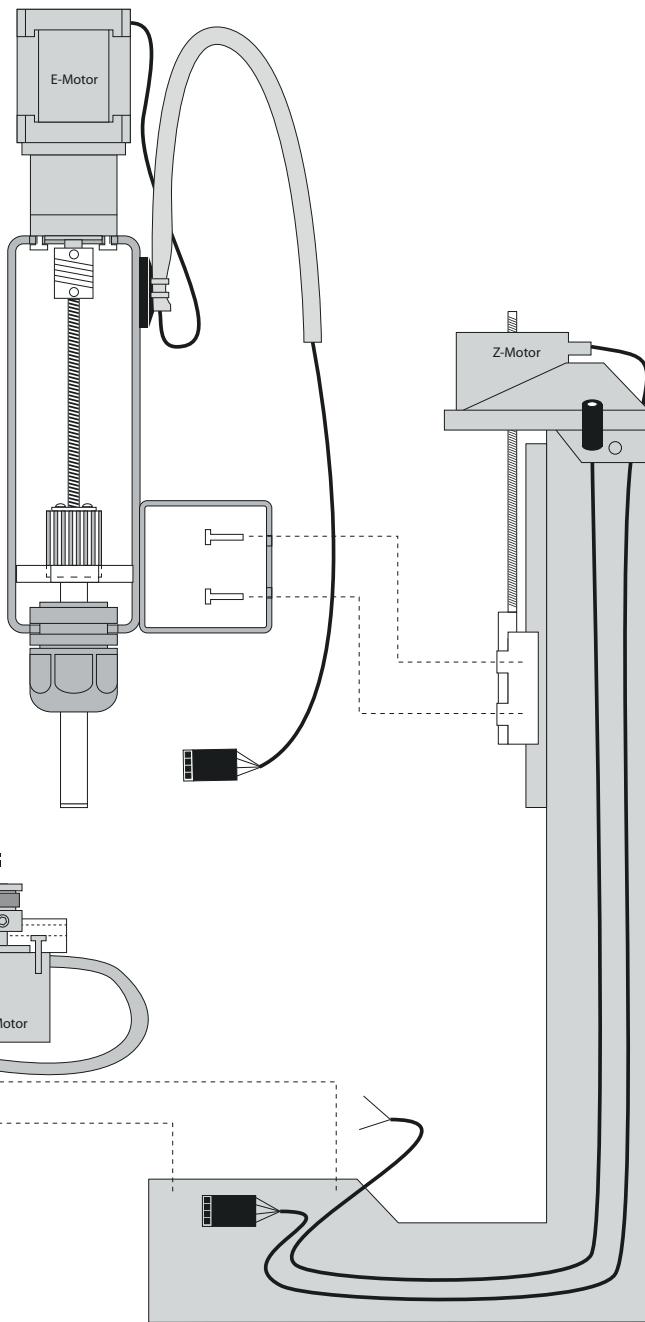
3. Attach E-Motor and Z-Motor wires to microcontroller board in base box.

4. Attach Utility Power wires from riser to microcontroller board.

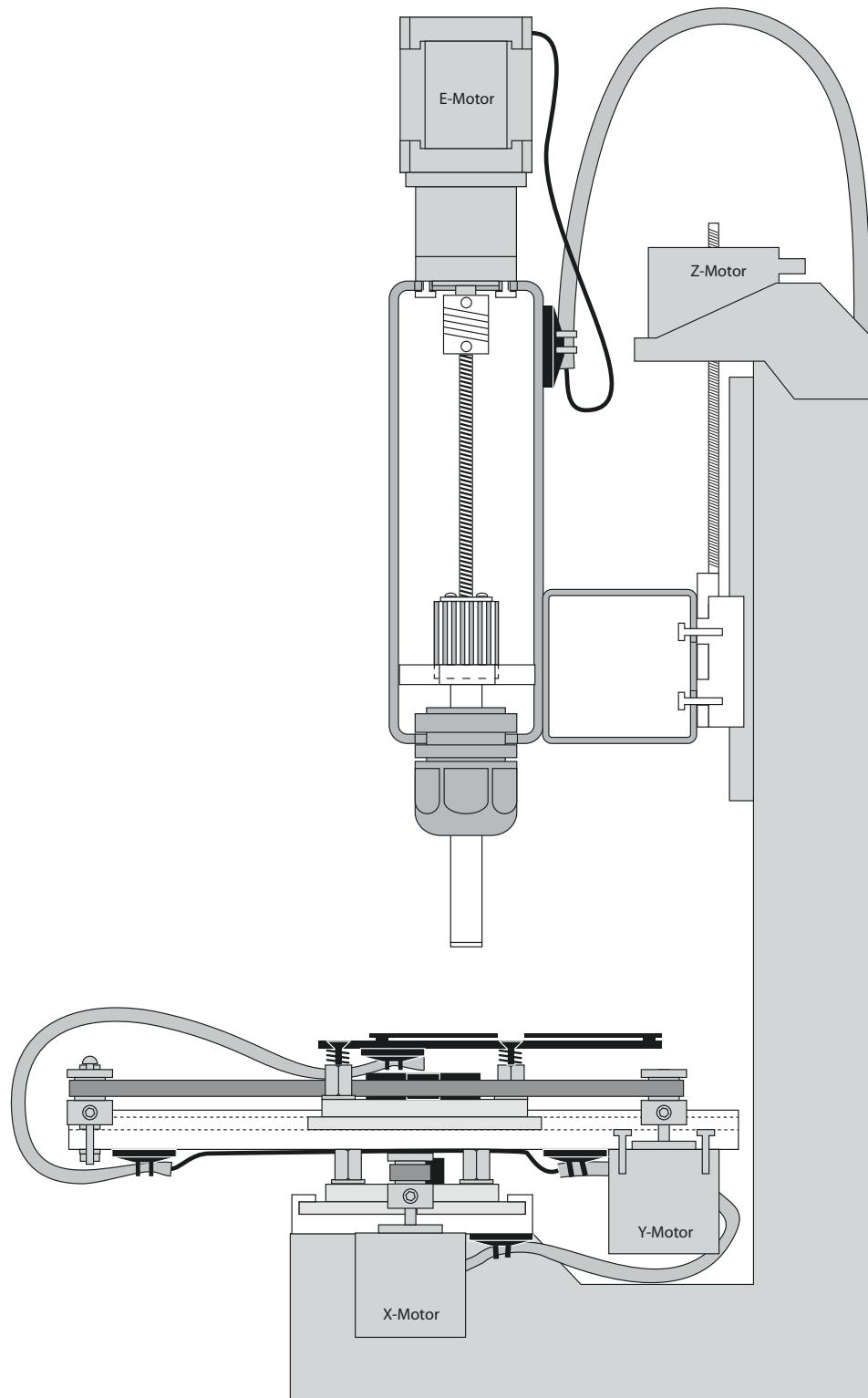
5. Attach X and Y endstop wires from the XY Unit to the Microcontroller board.

6. Attach the Y-Motor wire to the microcontroller board.

7. Bolt the XY Unit to the base box with six screws.

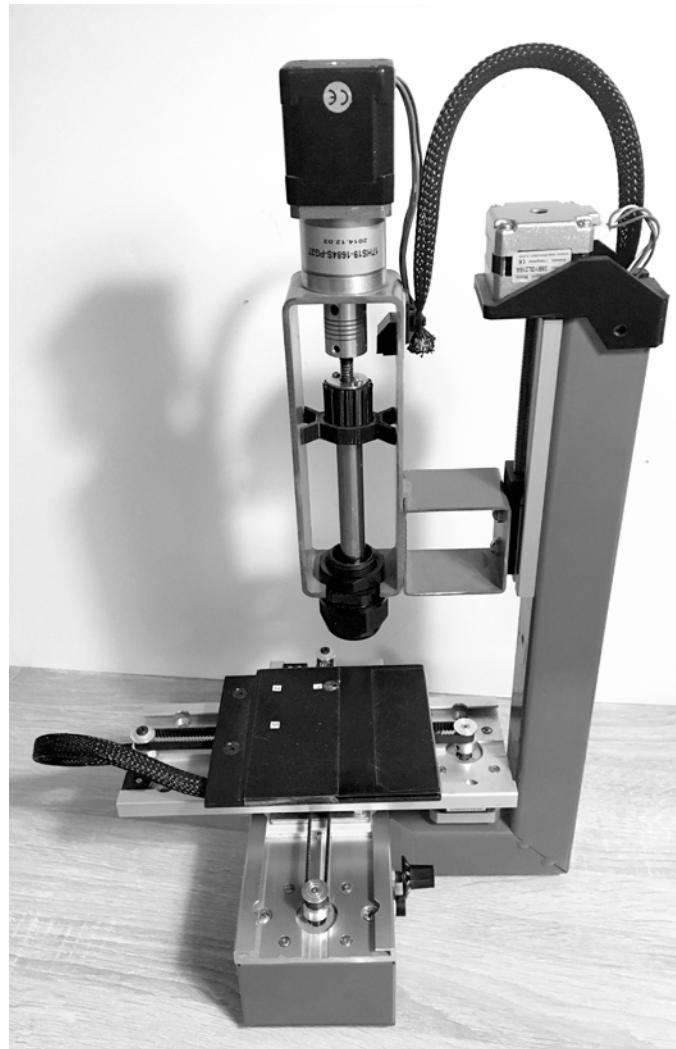


## 4.2 Final Assembly Guidelines



## 4.2 Final Assembly Guidelines

Completed Mini Metal Maker Pro hardware.



*Completed hardware of the Mini Metal Maker 3D extrusion printer.*

#### 4.3 Download and install firmware

The printer was originally released with modified MARLIN firmware. The commercially released code is available for free download from the following mirrored locations:

Idea Propulsion Systems Website

<https://www.ideapropulsionsystems.com/minimetalmakerpro>

Github

<https://github.com/dhartkop/MiniMetalMakerPro>

Google Drive

<https://drive.google.com/open?id=1qV-3hYl3GlgRwa2RdNpjQ69LkKmCXT83>  
(<https://tinyurl.com/ya7lxzjl>)

Drop Box

<https://www.dropbox.com/sh/klfxlgpdh6nvpl/AABd70FIQnrCqQLtLTAf8ZkPa?dl=0>  
(<https://tinyurl.com/ybynyh38>)

The firmware is meant to be opened within the Arduino IDE and installed onto the Arduino Mega card via a USB connection. It functions as a simple G-Code interpreter and allows the printer to be used with printing programs such as Sprinter, Slic3R, and Simplify 3D.

#### 4.4 Download User Manual

The complete user manual for the Mini Metal Maker Pro printer is also included among the documents available for free download on the above mirrored sites. The manual contains details for configuring and using the printer as it was originally intended.

This is a great little printer, and I bet you'll find something cool to do with it.

Have fun!

-David Hartkop :-)



NOTES: Syringe and plunger used with Mini Metal Maker Pro

