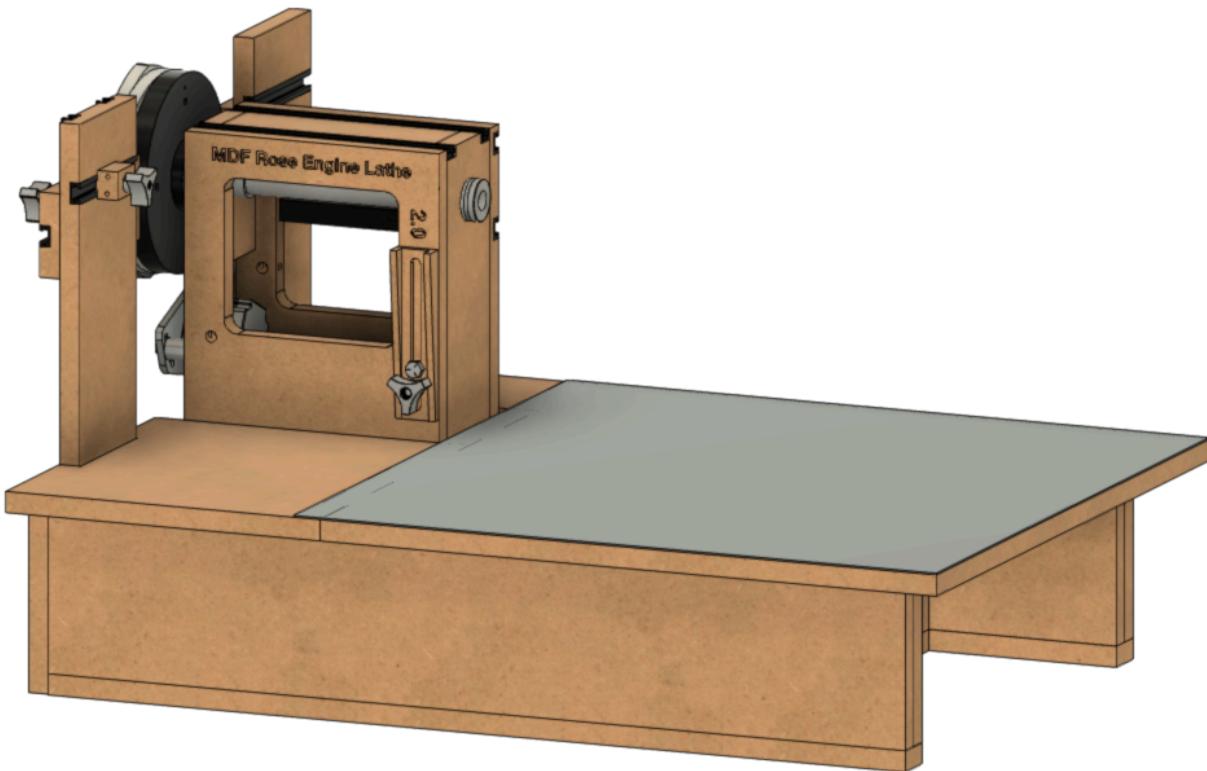


# **MDF Rose Engine Lathe 2.0 with Stepper Motor Drive**



## **Instructions for Building the Spindle-Only Stepper Control**

**Version 0.1  
01 January 2021**

# **MDF Rose Engine Lathe 2.0**

## **Build Instructions – Stepper Controls**

This document is intended to help one unfamiliar with the MDF rose engine to build one easily. It is designed to go with the kit you can purchase from [www.ColvinTools.com](http://www.ColvinTools.com).

There are some variations from the ideas documented by Jon Magill at [www.rogueturner.com](http://www.rogueturner.com). Where this is the case, we have tried to document such changes and provide the reason for the change.

This document is also designed to use a stepper motor for driving the spindle.

If you have any questions, please contact us at [ColvinTools@Gmail.com](mailto:ColvinTools@Gmail.com).

Good luck.

Rich Colvin & Jack Zimmel

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

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# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Getting Started

As you get started with building this machine, please consider making the machine according to the outlined instructions. There are a boatload of ways you can modify this, and, quite frankly, the MDF rose engine encourages experimentation. But it is best to attempt those modifications after understanding how it works. Some ideas which sound grand may not appear so after understanding how the machine works (we speak from experience).

If you have any questions on the terminology in this document, check out the “Ornamental Turning Book of Knowledge” ([www.OTBoK.info](http://www.OTBoK.info)).

This document outlines the approach for wiring this machine using a Pololu Tic 36v4 High-Power Stepper Motor Controller.

Advantages	Disadvantages
<ul style="list-style-type: none"><li>The cost is significantly lower than the full system design (using the Nextion display and Rose Engine Controller Spindle and Three Axes V002c printed circuit board).</li><li>This is simpler to implement.</li><li>If the implementer chooses to upgrade to the full controls system later, there is little investment which is lost (it is only the Pololu Tic and the rotary encoder).</li></ul>	<ul style="list-style-type: none"><li>This design can only control the spindle's stepper motor.</li><li>It could be duplicated for a 2d stepper motor; however, the two would not be synchronized.</li></ul>

Standards are outlined in a companion document and are used for the compilation of this document.

### Cautions

- Do not perform any changes to this system when the system is powered on.** Power down and unplug the system before attempting any work.
- If your local electrical code requires for any differences from what is documented here, those requirements take precedence over this document.
- If you feel uncomfortable with anything in these instructions, consider having a licensed electrician perform the work.

**Please also note:** Permission is not granted to manufacture these for sale.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

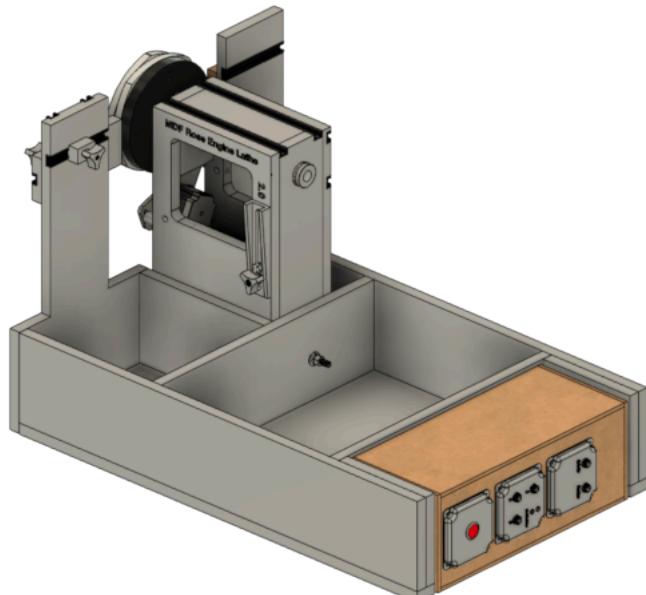
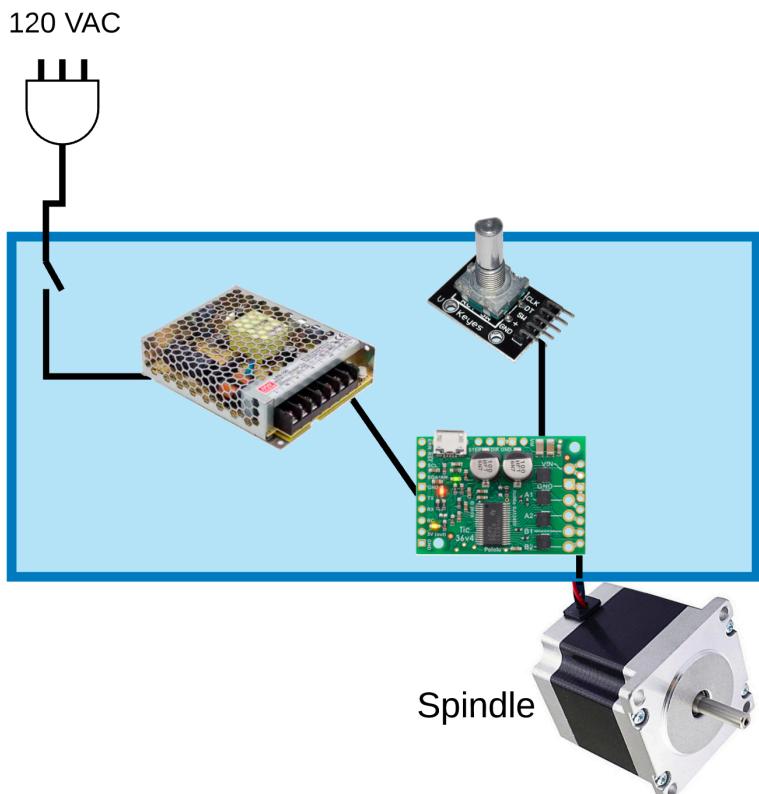
### Overview of Connections

The whole system is shown in the picture to the right.

Some have chosen to put the stepper motor controls in the lathe's carcass, under the bed of the lathe. However, placing all the pieces together in a separate box gives these benefits:

1. This controls box is designed be placed under the bed in the MDF Rose Engine Lathe 2.0 (as shown in the picture to the right {the bed cover is removed}).
2. This approach also allows for the controls box to be used with the original MDF Rose Engine Lathe, just placing the box somewhere near the lathe.
3. This also frees up space under the bed for:
  - a. Storage of parts or tools, or
  - b. Making a gap-bed lathe.
4. The connections to the stepper motors and limit switches are documented as standards. This allows for the creation of attachments (such as a curvilinear slide) with a built-in stepper motor and connecting it to the controls box.

The details for how to build the box for the controls are in the document for the full controls system and are not duplicated here.



MDF Rose Engine Lathe 2.0  
(B1 and B1A removed)

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

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### Bill of Materials

Parts required for building this are below. The item numbers are shown in the following drawings using an orange, circled number like the one to the right. For consistency with the full system, those item numbers are retained; however they are marked here as unused.

Item #	Item	Qty	Source	Source Part Number	Comments
	<b>Printed Circuit Board Assembly</b>				
101	(unused for this design)				
102	(unused for this design)				
103	(unused for this design)				
104	(unused for this design)				
105	(unused for this design)				
106	(unused for this design)				
107	(unused for this design)				
108	(unused for this design)				
109	Pololu Tic 36v4 High-Power Stepper Motor Controller	1	Pololu.com	3140	Tic 36v4 with connectors soldered
110	Rotary Encoder	1	Amazon		Cylewet 5Pcs KY-040 Rotary Encoder Module with 15×16.5 mm with Knob Cap for Arduino (5 pcs) CYT1062
	<b>Electrical Items</b>				
201	AC/DC Power Supply - LRS-100-24	1	Digi-Key	1866-3314-ND	
202	(unused for this design)				
203	(unused for this design)				
204	(unused for this design)				
205	Power Switch	1			SPST Toggle

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

Item #	Item	Qty	Source	Source Part Number	Comments
206	GX-16/ 4 Socket	4			May come as a pair of sockets and plugs (i.e., including #214)
207	(unused for this design)				
208	Utility box cover, 2 gang	2		Hubbell-Raco 804C	
209	Utility box cover, 1 gang	1	Amazon	Hubbell-Raco 861	
210	Utility box cover, 1 gang	1	Amazon	Hubbell-Raco 860	
211	3/8 in. Twin-Screw Cable Clamp Connectors	1	(hardware store)		
212	(unused for this design)				
213	Stepper Motor	1	StepperOnline	23HS30-30045	For the spindle drive NEMA 23 bipolar 1.8° 1.9 Nm, 2.8A, 3.2V 57 x 57 x 76 mm
214	GX-16/ 4 Plug	1	Amazon		May come as a pair of sockets and plugs (i.e., including #206)
	<b>Cables</b>				
301	(unused for this design)				
302	Cabling – 20 AWG/4, stranded				
303	Cabling – 20 or 22 AWG/2, stranded or solid core				
304	Cabling – 16 AWG/3, stranded				Can cut off the female end of a grounded extension cord.
	<b>Screws, etc.</b>				
401	Nylon Spacer (Unthreaded) for #8 screw – 1/4" OD, 1/4" length	4	McMaster-Carr	94639A293	Used to add space below the Pololu Tic when affixing it to something.
402	(unused for this design)				
403	(unused for this design)				
404	(unused for this design)				
405	(unused for this design)				

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

Item #	Item	Qty	Source	Source Part Number	Comments
406	Sheet Metal Screws, #4, 3/4" long, round head		McMaster-Carr	90935A137	These work acceptably in the MDF for the purposes they are designed to be used.
407	Particle Board Screws, #6, 3/4" long, round head		McMaster-Carr	91555A115	
408	Particle Board Screws, #6, 5/8" long, flat head		McMaster-Carr	90252A246	
409	(unused for this design)				
410	(unused for this design)				
<b>Spindle Drive Parts</b>					
501	Timing Belt	1	MiSUMI	GBN655EV5GT-90	GT3 5mm pitch 131T / 655mm long 9mm wide
502	Spindle Pulley	1	Colvin Tools		Attached to the spindle via the flange.
503	Stepper Motor Pulley	1	Stock Drive Products ( <a href="http://www.sdp-si.com">www.sdp-si.com</a> )	A 6A55-012DF0908	Attached to the stepper motor 5 mm (GT2) Pitch, 12 Teeth, 0.25" Bore, 2 Flanges / With Hub, Aluminum Alloy Timing Pulley for .354 (9mm)" Wide Belt
504	Stepper Motor Attachment Bracket & Parts	1	Colvin Tools		Includes: <ul style="list-style-type: none"><li>• Bracket with Idler</li><li>• Mounting bolts, nuts, and spacers to attach to headstock</li><li>• Mounting screws to attach stepper motor</li></ul>
<b>Touch Screen Parts</b>					
601	(unused for this design)				
<b>Optional Parts</b>					
901	(unused for this design)				
902	(unused for this design)				

# **MDF Rose Engine Lathe 2.0**

## **Build Instructions – Stepper Controls**

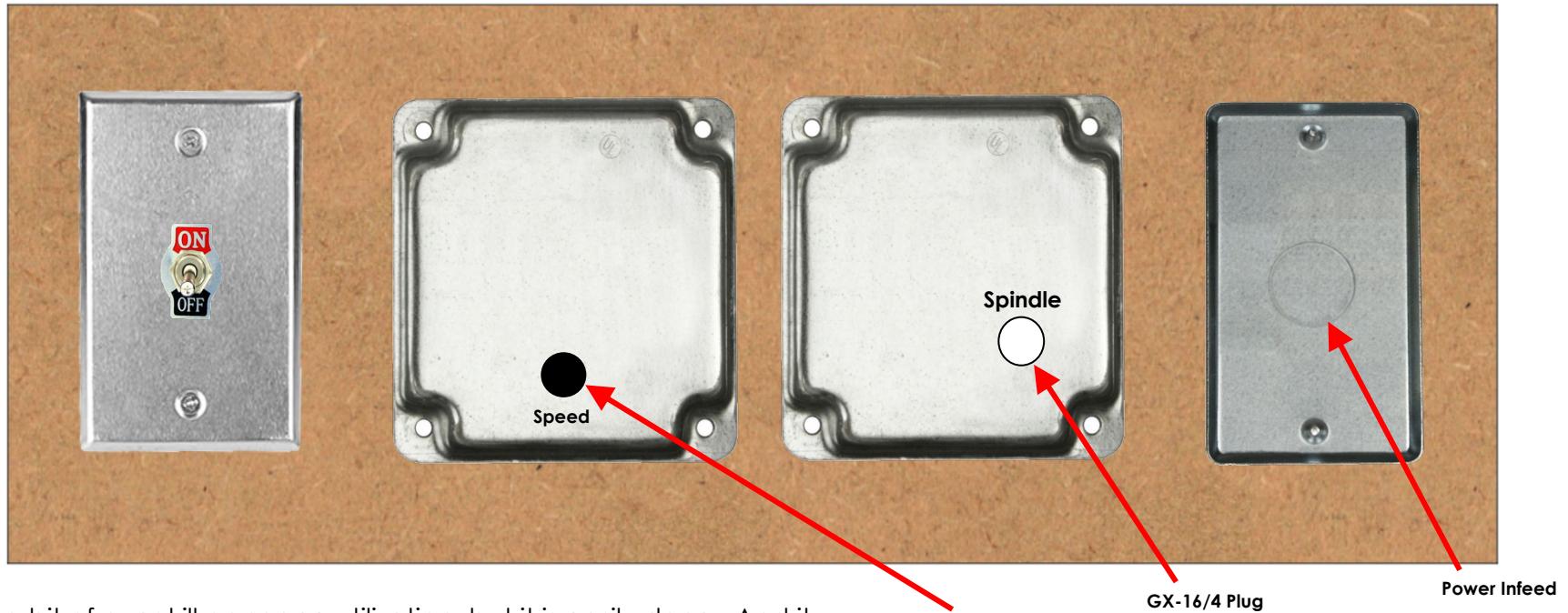
Not all screws are shown, only the ones which matter for size or are hard to find.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Controls Box Enclosure

One consideration for building the enclosure is for using the controls box as outlined for the full controls system.



This is a bit of over-kill on space utilization, but it is easily done. And it accommodates upgrading later to the full system if that is what is desired.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Connecting the Electronics

Attach the parts to the **Pololu Tic** using the instructions below.

#### Wiring – Power Supply (LRS-100-24)

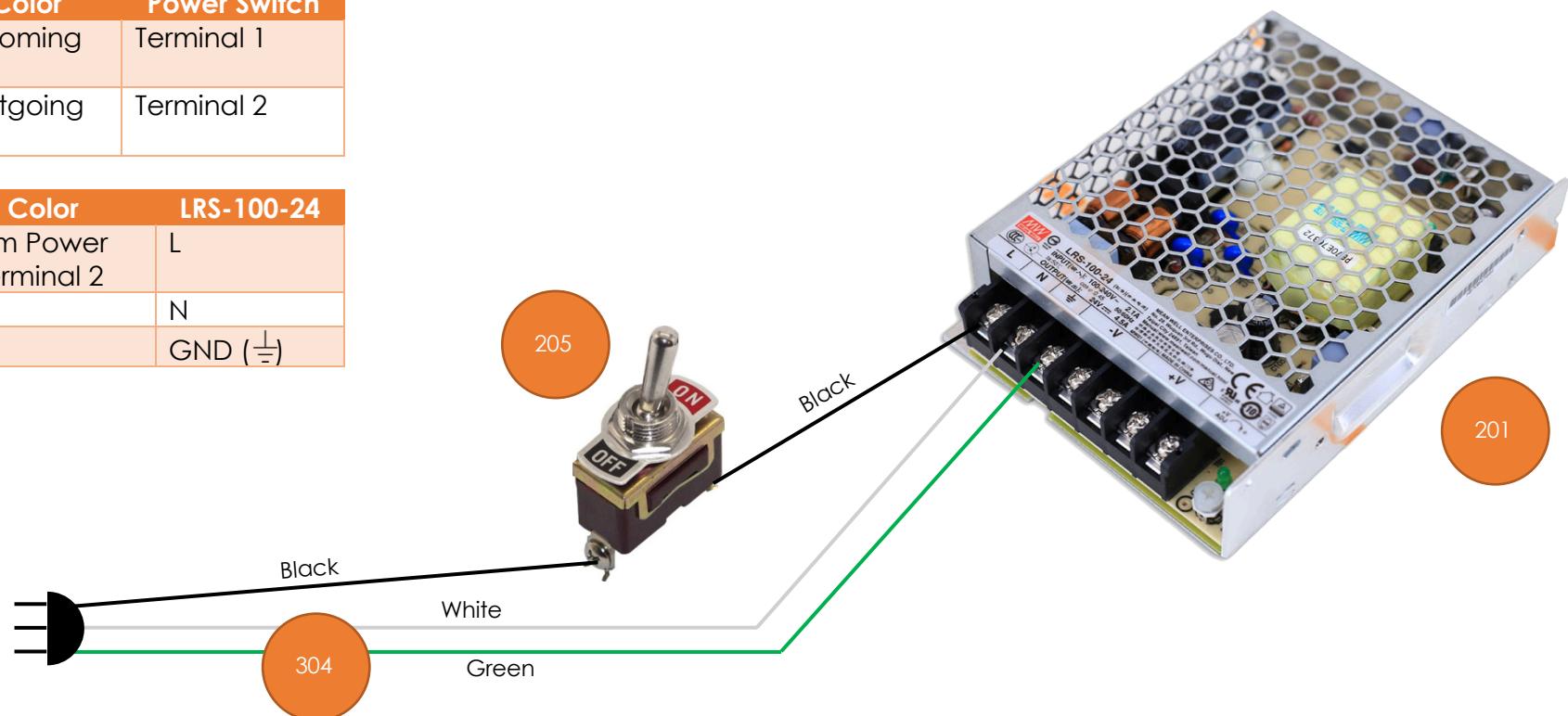
##### *Power Infeed*

The power infeed is connected as:

Wire Color	Power Switch
Black Incoming Power	Terminal 1
Black Outgoing Power	Terminal 2

Conductor Type	Stranded copper
Conductor Size	16 AWG (min)
Cable Size	3 conductors / cable

Wire Color	LRS-100-24
Black from Power Switch Terminal 2	L
White	N
Green	GND ( $\frac{1}{-}$ )



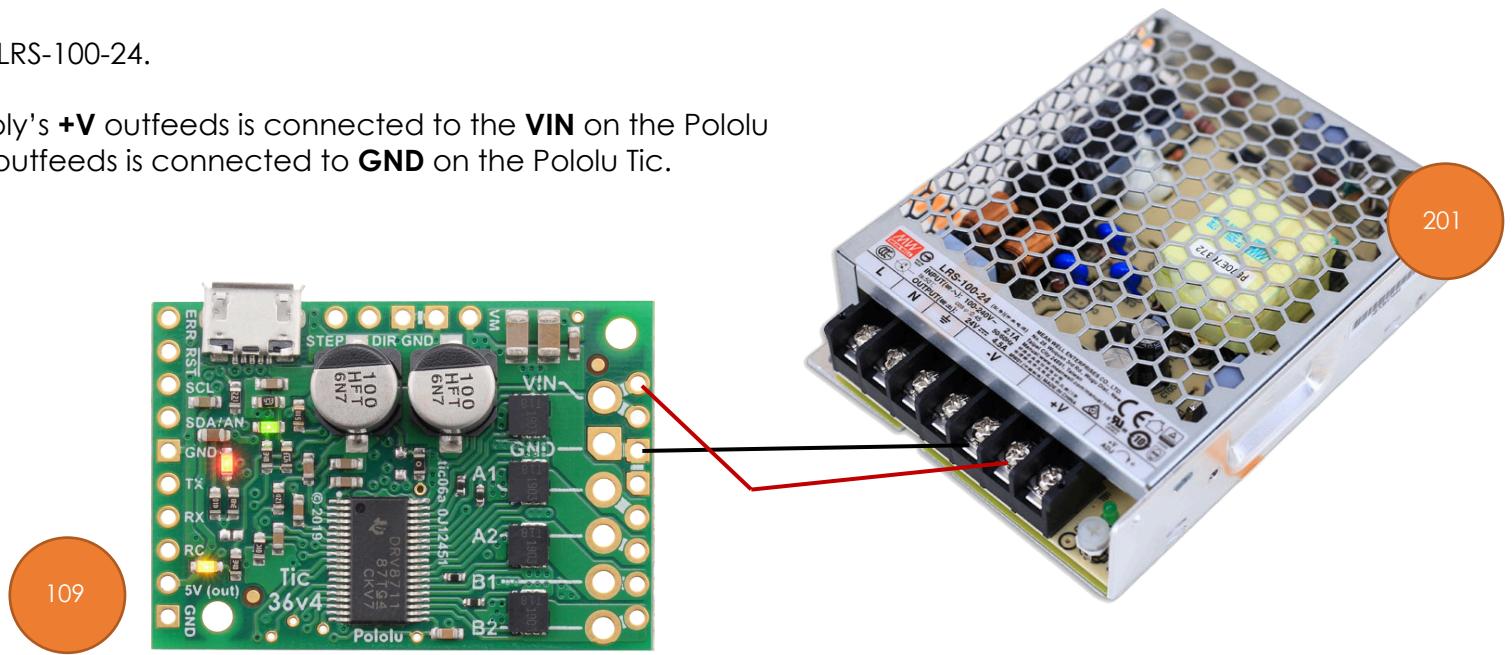
# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### *Power Outfeed*

The is powered by the LRS-100-24.

One of the power supply's **+V** outfeeds is connected to the **VIN** on the Pololu Tic, and one of the **-V** outfeeds is connected to **GND** on the Pololu Tic.



# MDF Rose Engine Lathe 2.0

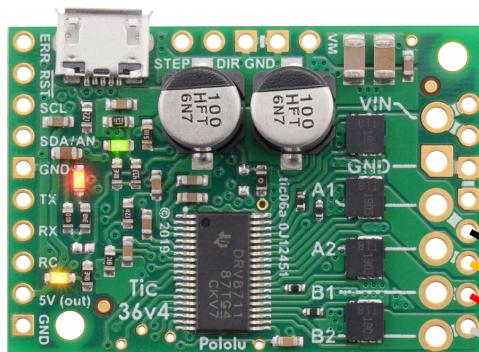
## Build Instructions – Stepper Controls

### Signal Wiring –Stepper Motor Drivers to GX-16/4 Jacks (4)

Each of the 4 stepper motors is connected to the stepper motor drivers via GX-16/4 Jacks.

Pololu Tic	Wire Color	GX-16/4 Pin
A1	Black	1
A2	Yellow	2
B1	Red	3
B2	White	4

Conductor Type	Stranded copper
Conductor Size	20 AWG
Cable Size	4 conductors / cable
Cable Length	6 to 8"



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302



206

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**NOTE:** When soldering wires to the GX-16 jack, it is a good practice to put a small dab of soldering flux onto the terminal before beginning the soldering. This will help it happen faster, minimizing the chance for damage to the jack.

Put flux here



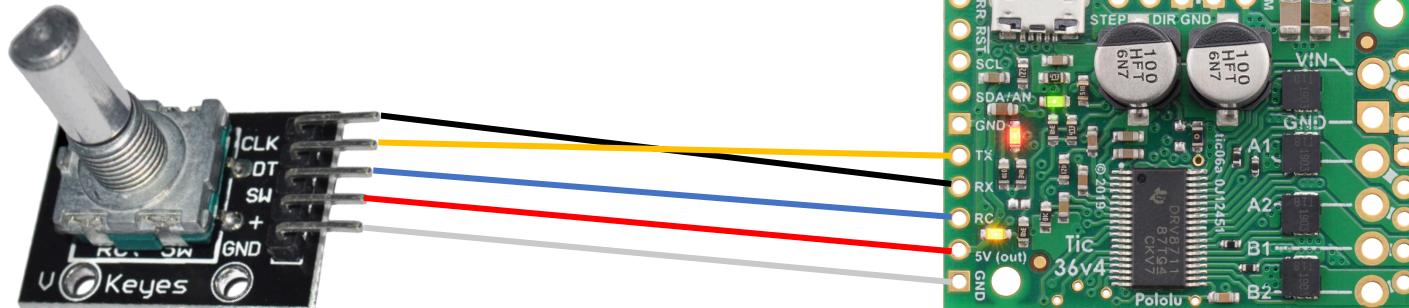
# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Signal Wiring – Pololu Tic to Rotary Encoder

The rotary encoder is used to start the spindle, set its speed, and stop it. Rotate the switch to increase/decrease the speed; depress the switch to stop the spindle (via the limit switch function).

Function	Rotary Encoder	Wire Color	Pololu Tic
Spindle Speed	CLK	Black	RX
	DT	Yellow	TX
	SW	Blue	RC
Limit Switch	+	Red	5V (out)
	GND	White	GND



110

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# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Configuration Settings

The Pololu Tic must be configured properly to work. The settings I have found to work are:

Option	Set to	Comments
<b>Control Mode</b>	Encoder Speed	
<b>Encoder</b>		
• Prescaler	1	
• Post Scaler	40,000	
• Enable Unbounded Position Control	✓ (checked)	
<b>RC &amp; Analogue Scaling</b>		
• Invert input direction	<input type="checkbox"/> (not checked)	
• Maximum Target	14,400,000	This is in pulses / millisecond and equates to 14,400 pulses / second. The formula for this setting is on the next page.
• Minimum Target	-14,400,000	This is also in pulses / millisecond
• Scaling Degree	1-Linear	Didn't seem to make a difference, so left at default.
<b>Motor</b>		
• Max Speed	14,400,000	
• Starting Speed	0	
• Max Accel	40,000	
• Use Max Accel for Deceleration	✓ (checked)	
• Step Mode	1/32 step	
• Current Limit	3,008 mA	
• Decay Mode	Auto Mixed	
<b>Advanced Settings</b>		
• SCL		(left at default)
• SDA/AN		(left at default)
• TX	Encoder Input	
• RX	Encoder Input	
• RC	Kill Switch	
<b>Soft Error Response</b>	Decelerate and Hold	

## MDF Rose Engine Lathe 2.0

### Build Instructions – Stepper Controls

The maximum spindle speed with these settings is calculated as:

$$\text{Max Motor Speed} = \frac{14,400 \frac{\text{pulses}}{\text{sec}} * 60 \frac{\text{sec}}{\text{min}}}{32 \frac{\text{pulses}}{\text{step}} * 200 \frac{\text{steps}}{\text{rotation}}}$$

$$\text{Max Motor Speed} = 135 \text{ rpm}$$

$$\text{Max Spindle Speed} = 135 \text{ motor rpm} * \frac{12 \text{ motor pulley teeth}}{108 \text{ spindle pulley teeth}}$$

$$\text{Max Spindle Speed} = 15 \text{ rpm}$$

# MDF Rose Engine Lathe 2.0

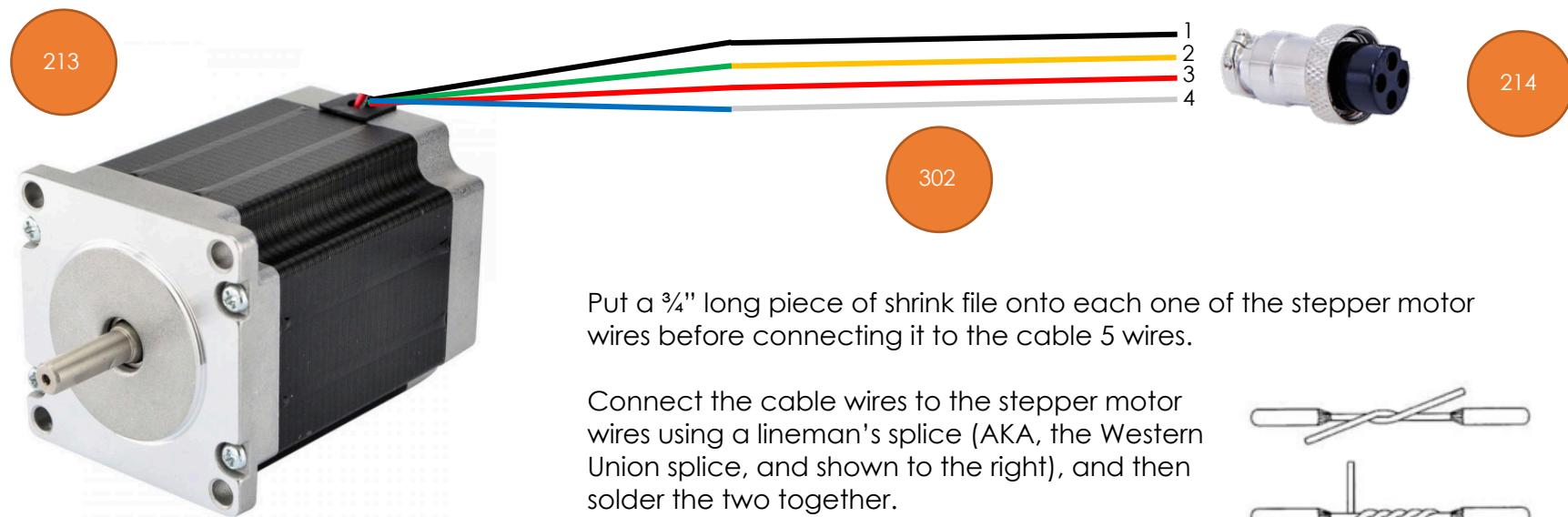
## Build Instructions – Stepper Controls

### Motor Connections

The spindle stepper motors is connected to the Pololu Tic via a GX-16/4 plug. For the spindle drive, a 3-foot cord is recommended. Stepper motor wire colors shown are for the StepperOnline motors. Check that the one you use matches for the connection needed.

Stepper Motor	Stepper Motor Wire	Cable Wire Color	GX-16/4 Pin
A+	Black	Black	1
A-	Green	Yellow	2
B+	Red	Red	3
B-	Blue	White	4

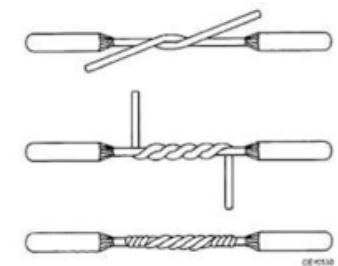
Conductor Type	Stranded copper
Conductor Size	20 AWG
Cable Size	4 conductors / cable



Put a  $\frac{3}{4}$ " long piece of shrink file onto each one of the stepper motor wires before connecting it to the cable 5 wires.

Connect the cable wires to the stepper motor wires using a lineman's splice (AKA, the Western Union splice, and shown to the right), and then solder the two together.

Heat the shrink file tubing around each of the joints to insulate it from the other things it could touch.



## MDF Rose Engine Lathe 2.0

### Build Instructions – Stepper Controls

Alternatively, you can add a back cover to the stepper motor. This gives a secure way to attach the signal wires to the motor. These are available from a number of sources, and they can even be 3D printed. Look for one online using the term "stepper motor back cover".

In this case, connect the stepper motor to the GX-16/4 jack as:

Stepper Motor	Stepper Motor Wire	GX-16/4 Pin
A+	Black	1
A-	Green	2
B+	Red	3
B-	Blue	4

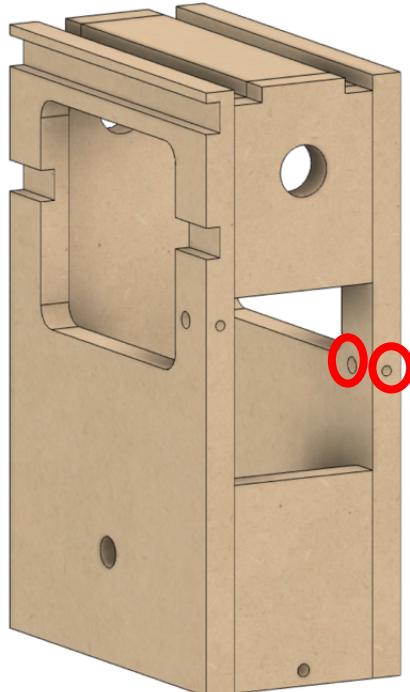


# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Attaching the Stepper Motor to the Headstock

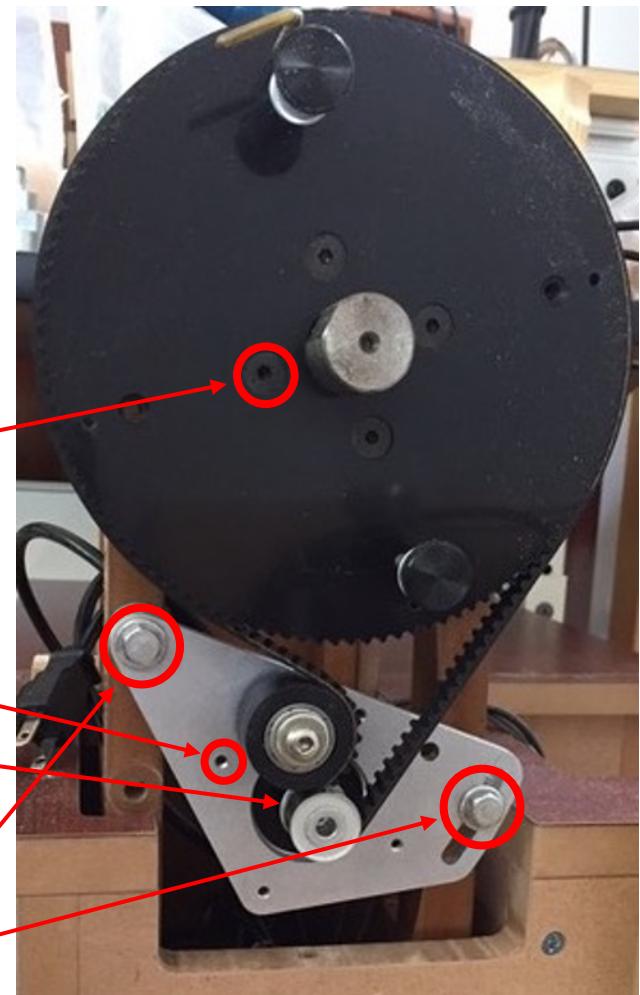
The stepper motor attaches to the headstock as shown in the picture to the right.



If you purchased the kit we supply, the holes on the left and right are already set properly. If you built it yourself, you will now need to drill the holes for the screws on the right. As noted in the case building instructions, these need to be set based on the alignment of the bracket.

- 502 Attach the spindle pulley to the spindle flange. There are 4 screws for this. One is indicated here.
- 504 Attach the stepper motor to the bracket using 4 screws. One is indicated here.
- 503 Secure the 12-tooth drive pulley to the stepper motor's spindle.

Attach the bracket to the headstock on both sides. There are two screws and two spacers (they look like thick washers). The spacers are installed between the bracket and the headstock. They are held onto the headstock using barrel nuts. Do not tighten them just yet.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

**NOTE:** The picture on the right is of the assembly on the original MDF rose engine lathe. On version 2.0, there is no need for the cutout in the base to accommodate the bracket.

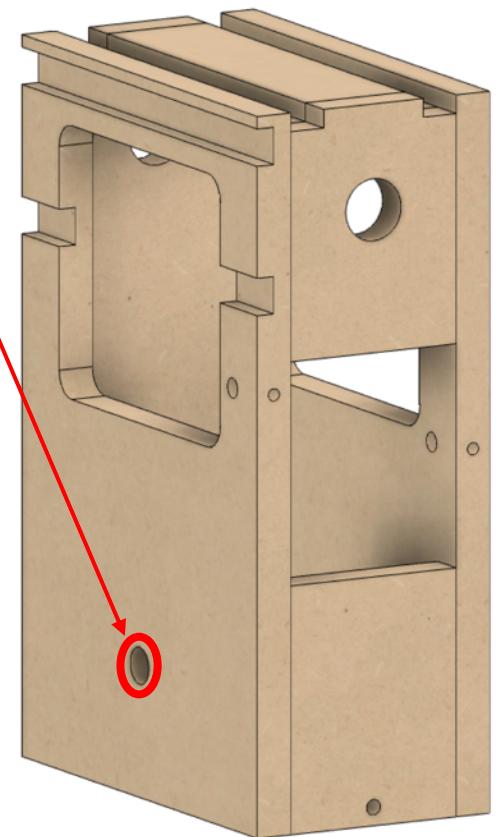
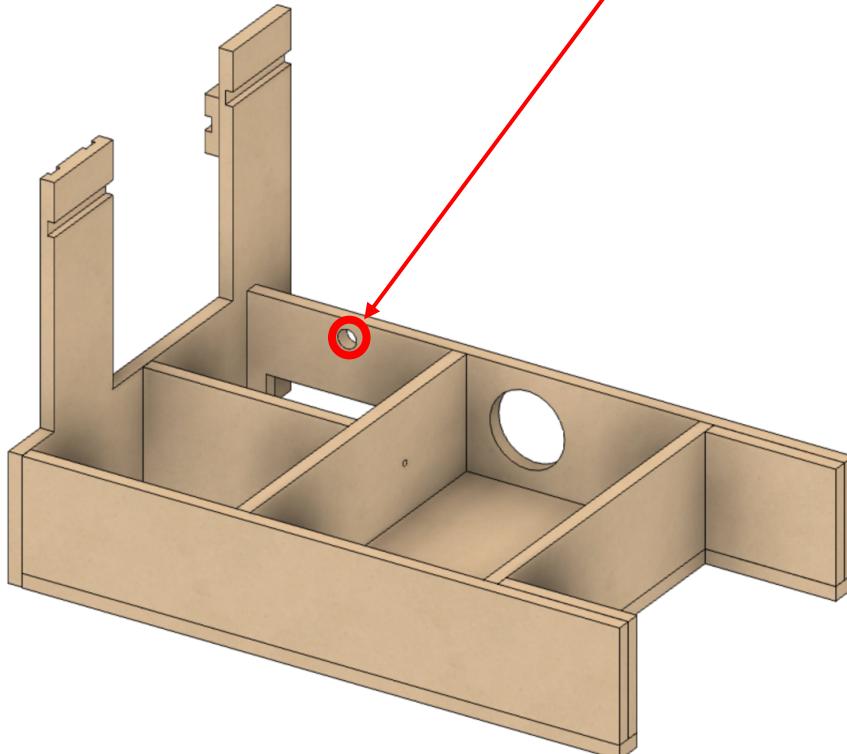
Install the timing belt (item #501).

Snug the bracket so that the timing belt is tight enough that it won't slip, but not so tight that it stretches. Once it is set, tighten the two bolts holding the bracket to the headstock. They need to be tight enough to not slip, but don't over tighten them as that will cause the barrel nuts to pull thru the MDF.

The stepper motor's cable needs to be fed thru the hole in the back of the headstock, and continue out of the lathe thru the hole in the back of the bed.

### Recommendation

Unless you are an electrical / automation engineer or have substantial experience in this space, the design outlined with external stepper motor drivers will be easier to implement over the long term.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Stepper Controls

### Document Version History

Ver	Date	Comment
0.1	01 Jan 20	Initial document

# **MDF Rose Engine Lathe 2.0**

## **Build Instructions – Stepper Controls**

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